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A PERUVIAN HYDROELECTRIC INSTALLATION

BY A. L. WILCOX.

REPORT OF PANAMA-PACIFIC CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

GOVERNMENTAL CONTROL OF WATER POWER

BY F. O. BROILL.

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Dearborn Chemical Co.

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The

Pacific States Electric Co.

is co-operating to make the great

Edison Day Campaign

an unprecedented success and the name of

Edison Mazda Lamps

a by-word in every household throughout this great West, by helping dealers arouse the interest and enthusiasm of the boys and girls in the

Edison Day Contest

and the wondrous illuminating and endurance powers of Edison Mazda Lamps.

Are the young folks pulling for you—have you told them of the prizes they can win? Get them busy now.

On this occasion, as in all others, the Pacific States Electric Co. has endeavored to show that spirit of true co-operation with and loyalty to dealers which it endeavors always to make characteristic of its business relations with the various branches of the electrical industry.

MR. DEALER—If you do not sell Edison Lamps, link up now with a line you positively know carries with it co-operation—gives you absolute sales support with quick and big returns.

PACIFIC STATES ELECTRIC CO.

The Modern Electrical Supply House

Distributors for the Pacific Coast

LOS ANGELES OAKLAND PORTLAND
SAN FRANCISCO SEATTLE

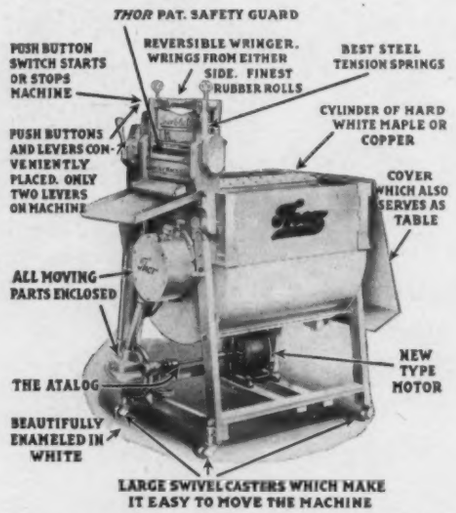
Another whole carload of

Thor

ELECTRIC HOME LAUNDRY MACHINES

arrives—the third to reach the Pacific Coast and be disposed of in less than sixty days.

This shows the vigor and enthusiasm back of and the success that is crowning the work of the big Thor Sales Campaign in the West.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Dealers everywhere are amazed over the quick sales and big profits they have thus far secured in having joined and taken advantage of the Thor "get acquainted" campaign.

Shipments by the carload should indicate to you, Mr. Dealer—there's something doing in the sale of Thor Machines. Don't wait another day. Put one on your floor now, where it can be demonstrated. Lay hold of the profits that simply await slight effort on your part.

Find out about our partial payment plan. It is an added inducement to offer your customers. Tell your Central Station man about it. He'll help boost, because it popularizes electricity.

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PACIFIC STATES ELECTRIC CO.

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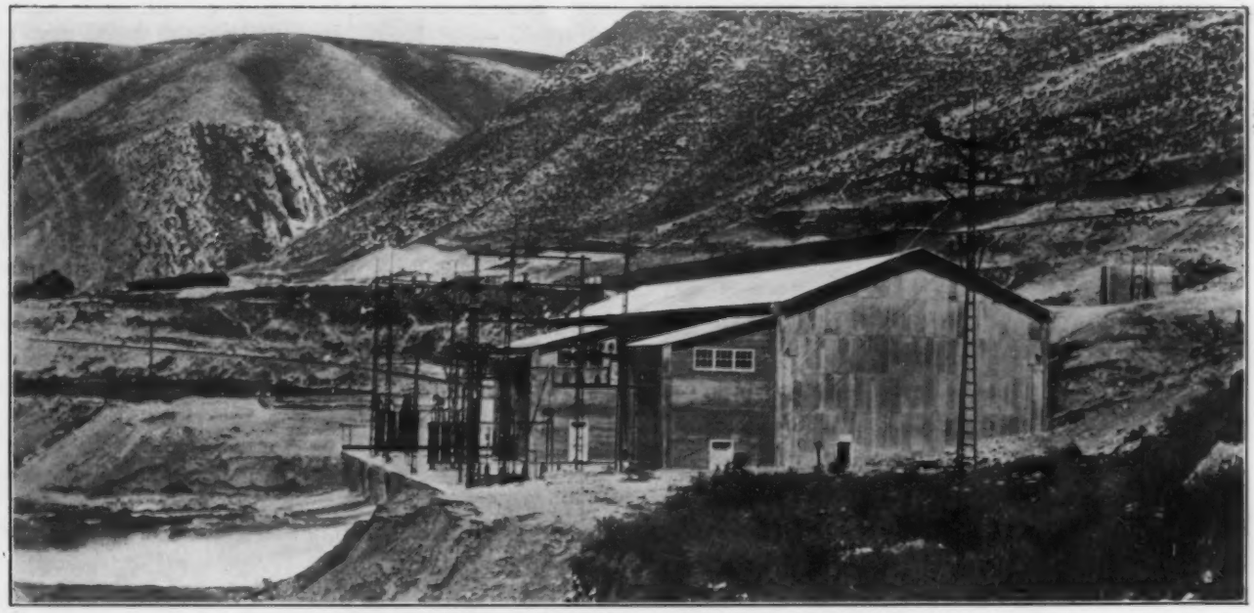
A PERUVIAN HYDROELECTRIC INSTALLATION

BY A. L. WILCOX.

(This illustrated description of an 11,250 k.v.a. power plant on "the roof of the world" is one of the first examples of American electrical enterprise in South America. Details are given of the hydraulic and generating equipment, together with brief discussion of labor and climatic conditions.—The Editor.)

Recent attempts on the part of American manufacturers to enter the South American markets and the closer trade relations now existing between the two continents add interest to an important hydroelectric installation, recently completed in the Cerro de Pasco mining district of the Republic of Peru. Aside from the general interest because of its geographical location the altitude at which the Cerro de Pasco plant lies and labor conditions make it of more than ordinary interest.



Oroya Power House, showing Transmission Line Terminal.

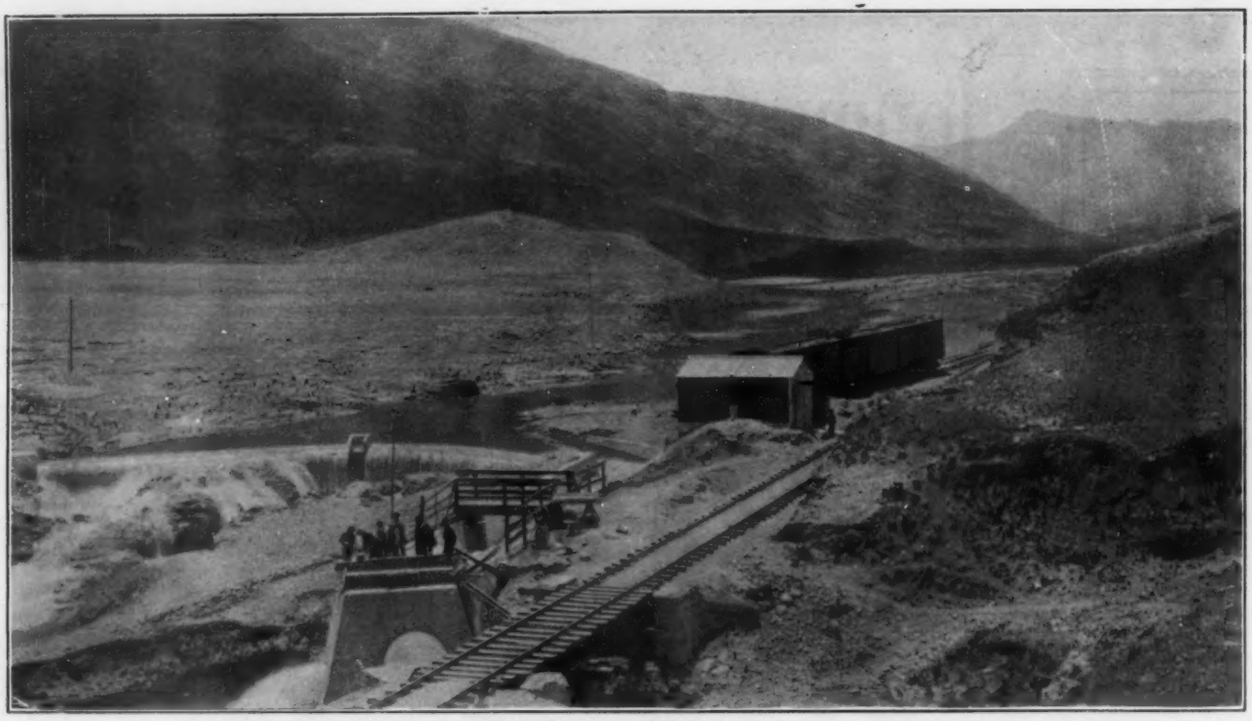
The Cerro de Pasco mines have been worked for silver since the early Spanish days (1550). They have been a continuous producer of silver but it has only been during the last twenty years that they have attracted attention as copper properties.

The town and mines of Cerro de Pasco are 216 miles from the Pacific Ocean, on top of the second cordillera of the Andes Mountains at an elevation of 14,300 ft. and are reached by a day's trip over the Peruvian Central and Cerro de Pasco Railways.

Starting at Callao, the principal seaport of Peru, the Peruvian Central makes a steady climb for 108 miles and crosses the first cordillera of the Andes at Galera tunnel, elevation 15,665 ft. From Galera the road takes a drop to Oroya, (distant 138 miles from Callao), to an elevation of 12,300 ft. At Oroya, a division point on the Peruvian Central Railway and a terminus of the Cerro de Pasco Railway, is located the generating station of the system hereinafter described.

As at present constructed the system consists of a generating station composed of three 3750 k.v.a. water wheel driven generators, substations at Morococha, Smelter, Cerro de Pasco and Goyllarisquisga and a steam reserve plant at Smelter.

Water is taken from the Yauli, a river that has its



Intake and Dam.

source in the high glacial peaks around Mt. Meiggs and forms part of the headwaters of the Amazon. The

Oroya Power House, showing Penstock Location.

diversion point for the water is at Chaplanca. At this place the valley narrows and the river passes through a cleft in the rocks.

A constant angle, arch type of concrete dam, 72 ft. high, here diverts the flow of the Yauli into a canal about 10 miles long. Included in the canal are four tunnels, an inverted syphon, or U-tube, and approximately 3300 ft. of wooden flume. About half the canal is concrete and masonry lined. The grade is one foot in a thousand.

At Saco Quebrads, the location of the U-tube, a feeder ditch adds 5 cu. ft. per second to the water supply. At the end of the canal a small regulating reservoir has been built. Its capacity is 37 acre feet, giving sufficient water to carry the entire load until the steam reserve at La Fundicion comes into operation.

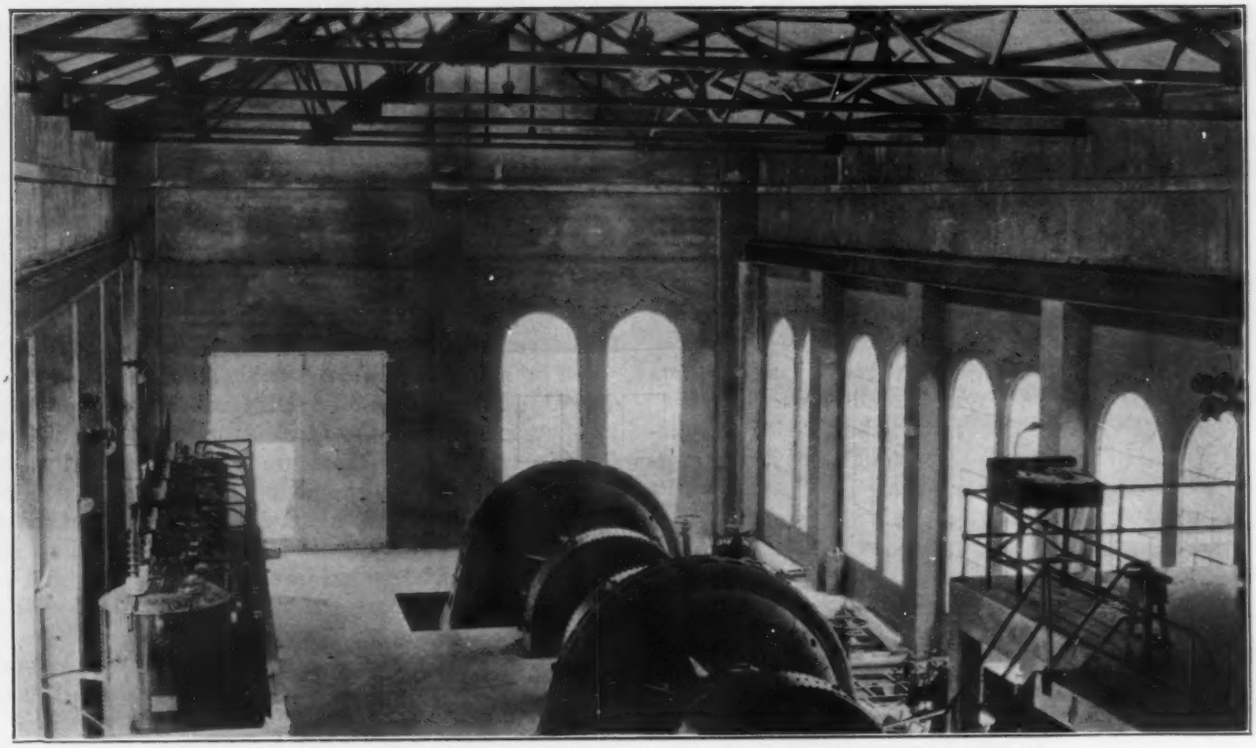
The penstock leads directly from the regulating reservoir to the power house, the static head on nozzles being 719 ft. The penstock, which is without horizontal angles, is 4598 ft. long, has a diameter varying from 62 to 42 in. and is made up of riveted sheet steel. It ends in a header pipe with six branches, leading to the nozzles.

The power house is a reinforced concrete building 46 by 120 ft. It lies parallel to the river and at right angles to the penstock. The north end of the power house is temporarily constructed of galvanized iron, the idea being to permit of an easy extension of the building in case a fourth unit is installed.

The station contains the three main units, two water wheel driven exciter sets, three banks of three transformers each, and a central oil pressure system for the governors.

The switchboard is on a gallery at the center and rear of building and insures the switchboard operator of a view of the entire generator floor. A twenty-five ton crane runs the full length of the building.

The generators are 3750 k.v.a., 60 cycle, 2300 volt, 300 r.p.m. Prime movers are double overhung im-



Interior Oroya Power House, showing Units Nos. 1 and 2 and Transformer Bank.

pulse type turbines, with governor operated deflecting nozzles and hand controlled needles.

Two rotary pumps, both motor and water wheel driven, supply the governors with oil under a pressure of 145 lb.

Exciter units each consist of a 150 kw. direct current generator, driven by an a.c. motor and a single horizontal overhung type water wheel, with stationary nozzle, directly operated by hand or by a mechanical governor.

The transformer capacity consists of nine 1000 kw. water cooled, single-phase, 60 cycle transformers, arranged in banks of three each. Current is generated at 2300 and transmitted at 44,000 volts.

Between each generator and its transformer bank, below the floor level of the main generating room, is a switch chamber containing disconnecting switches, automatic and non-automatic circuit breakers, potential and current transformers. A 2300 volt bus runs the full length of the switch chambers.

Outside the main generating room are three switch rooms for high tension switches, each room containing an automatic and non-automatic set. Between these switches is a high tension bus. The arrangement of buses allows current from either generator to pass through either bank of transformers and on to any circuit of the transmission line from the high tension bus.

All switches are electrically controlled from the switchboard.

Current is transmitted from Oroya to the smelter at La Fundicion over two three-phase circuits and from Smelter to copper mines at Cerro de Pasco and coal mines at Goyllarisquisga over three-phase circuits. A third line also reaches from Oroya to the mines at Morococha, a camp to the south and west of Oroya. The system is protected from lightning by twelve sets of electrolytic arresters. The total length of transmission lines is 124 miles.

Piping Under Peruvian Central Railroad, also showing Concrete Ditch.

Transmission Line at Oroya, showing Tripartite Poles.

The circuits are of seven-strand No. 1 copper wire, the mines furnishing the copper.

The minimum flow in the Yauli is 125 cu. ft. per second but the development of Lakes Huallococha and Huescacocha, as storage reservoirs, provides at present a storage of 15,000 acre feet, sufficient for the company's needs for some time to come.

The storage dams, one of which contains 20,000 cubic yards, were built with earth placed by wheelbarrows.

Transportation to the job presented no difficulties as the work is mostly along the railroad. Delivering material to some parts of the transmission lines was slow and tedious as no wagons could be used.

The seasons are sharply defined, there being a distinct wet and dry period. The rainfall above the storage lakes averages 25 in. per year. The wet months are from December until May, the remainder of the year being dry, except for snow flurries and occasional showers.

On the western slope of the mountains the rainfall is considerably less than on the eastern slope and rain seldom falls below an elevation of 2000 ft. As a result there is a strip of an average width of thirty miles along the Peruvian coast, which includes the capital and chief port, where rain is almost unknown.

The labor used on the work was all Indians, inhabitants of the neighborhood and adjacent country. The Cerro de Pasco Mining Company, for whom the work was done, have trained numbers of Peruvians as mechanics, so that practically the only foreigners on the job were the foreman and the electrical men.

The Peruvian Indian is a shiftless person, not inclined to work hard but capable of doing so. No shelter or boarding houses need be provided for him. At the start of a job he brings his family and provisions so that a commissary is not an essential either. His first days in camp are spent in building, either a hut of rock walls, over which he puts a roof of grass, or a dug out with similar roof. A cave on which he need expend no labor is more to his liking.

The life of the Peruvian Indian is an argument against socialism. Community life is the hard and fast rule and all properties are community owned. The communities are organized and the communal officers serve only for one year's time.

The actual cost of the work described closely approximated the estimated cost and the cost per kw. developed was about the average of the cost of California developments. The engineering design and construction were performed by F. G. Baum & Co. of San Francisco.

SALVAGE OF MAN'S EFFICIENCY.

BY W. A. BRACKENRIDGE.

To minimize the wanton waste of human efficiency, is to my mind the greatest problem that faces the management of industries where the number of employes is large. Building up and maintaining an organization, has enormous possibilities for failure or success. An organization is a human structure composed of individual human units, and its success is only achieved when each unit performs to its best its individual part.

Our memory runs back reviewing the rise and fall of political organizations and factions dominated by bosses. We scan the newspapers of today and we continue to note the ascendency and the decline of other political bosses and the disintegration of their organizations. The principal object of these political organizations and factions is to place men in the public employ—city, state and nation. So rapid are the changes in bosses and employes that they seem like a kaleidoscopic scene—shifting and ever shifting.

The man who holds position or employment under these unstable conditions is frequently to be pitied. He has to cling to the fortunes of his political boss for his existence. To secure his political job he usually spends an enormous amount of time and often money, and by promising and pledging he entangles himself with obligations which cannot be shaken off, and which become a compromising and humiliating burden. It is commonly said, and I assume that it is approximately true, that a man holding a position in the gift of a political organization, has to spend about seventy-five per cent of his time and energy to hold his job. This drain upon his efficiency constitutes a minus factor which can scarcely fail to result in inefficiency.

Of course the public pays for this loss in waste and energy, but from a humanitarian standpoint that is the least of the losses. The tragedy of it is this—the man is wasted.

History of private enterprises amply bears out the contention that they have developed the highest efficiency of the man and minimized waste. The Hudson Bay Company, which brought the wilds of British America under civilization, and the British East India Company which performed even greater achievements in Asia, are notable examples of successful development under an administrative policy where politics were very remote from the individual working unit. During the recent period of hysterical clamor against corporations, the fact that these organizations of brain, labor and money have developed all of our commerce, industry, transportation, and indirectly all of our agriculture, has been lost sight of.

Analyze any of the great privately conducted achievements and you will find that both officials and the men of the rank and file did their wonderful work because they could concentrate upon it. Good work and good conduct assured practical perpetuity of employment and left the man free to do his best. It is most encouraging to note, that at last this splendid factor of success is receiving recognition all over the country. The press is proclaiming and applauding the welfare work of corporations and private industries. This recognition comes late, but is nevertheless welcome. In the loyalty and devotion which exists among Edison men I believe the company has its best asset. Of my various official duties, I consider as most important the work which will aid in reducing the waste of mentality and labor to the minimum, and develop the man to his highest efficiency.—Edison Current Topics.

PANAMA-PACIFIC A. I. E. E. CONVENTION

The Panama-Pacific Convention of the American Institute of Electrical Engineers at San Francisco, September 16, 17 and 18, 1915, was in many respects one of the most successful meetings yet held. This was largely due to the large attendance of Eastern members who contributed much interesting discussion and in turn were afforded abundant opportunity to learn of the conditions peculiar to the West.

Particular credit for the success of the convention should be accorded to the convention committee consisting of W. W. Briggs, A. G. Jones, A. H. Babcock, A. M. Hunt, H. A. Lardner, J. T. Whittlesey, C. J. Wilson, C. L. Cory, Harris J. Ryan, L. T. Robinson, H. H. Barnes Jr. and Geo. F. Sever. A most comprehensive list of papers had been prepared and every arrangement perfected for the comfort and convenience of the guests. The list of registrations showed over 350 members and guests.

The convention was called to order at 10:20 a. m., September 16th, in Native Sons' Hall by President J. J. Carty. President Carty stated that this convention was particularly notable because it was held in conjunction with the celebration of a great engineering feat, the building of the Panama canal. Being held in the West it offered an excellent opportunity for brother engineer to meet brother engineer and offered evidence that the Institute is national in its scope.

Professor Harris J. Ryan, honorary vice-president, speaking in behalf of the electrical engineers of the Pacific Coast, extended hearty welcome and stated that the meeting was made notable by the presence of so many Eastern men and also because of its being held at the time of the Panama-Pacific International Exposition, the first to be completed since people had ceased to say that electricity is in its infancy.

Secretary F. L. Hutchinson spoke of the excellent work of the local committee which had relieved him of his usual duties and made it possible for him to get acquainted with the members. He made announcement of the conventions of the other societies being held at the same time. Other announcements were made by W. W. Briggs and H. A. Lardner.

The meeting was then subdivided into several sections to discuss the long list of technical papers which had been provided. Brief abstract of these papers and discussions are as follows:

D.C. Commutating Machinery.

B. G. Lamme showed that in direct current machines, such limitations as sparking at brushes, flashing at the commutator, burning and blackening of the commutator face, picking up of copper, etc., are special cases of well known phenomena. The theory of commutation was considered only in its relation to the e.m.fs. generated in the coils short circuited by the brush; and the limiting e.m.fs. per commutator bar and per brush were shown to be fixed principally by brush contact resistance. The effects of the negative coefficient of the contact resistance was also referred to briefly.

Flashing due to various causes was next taken up, and the relations between the maximum volts per bar and flashing conditions indicated, both from test and general experience. Flashing due to various other causes, such as interrupting the circuit, etc., was also considered.

Burning and blackening of commutators, high mica, picking up of copper, etc., were treated in detail, and these actions shown to be very closely related to the commutation limits derived in the earlier part of the paper.

Noise, vibration, etc., were also considered as limitations in design of d.c. apparatus. In approaching the ultimate design, these limitations become increasingly prominent.

Flickering of voltage and winking of lights are two well known actions in direct current practice. A simple explanation of the winking of lights was given with the results of tests on a generator with well proportioned compensating windings in the pole faces. Apparently the difficulty is a fundamental one, and is liable to occur in all types of d.c. machines.

In conclusion, a brief chapter was given on design limitations as fixed by commutator peripheral speed. This applies particularly to large capacity high voltage machines.

An appendix covered a method for determining the maximum capacity of d.c. machines in terms of the short circuit volts per commutator bar when the various constants in the machine are given certain limiting values. The results show that in large high speed machines, the maximum capacity is considerably above present practice.

In the absence of Mr. Lamme, this paper was abstracted by Frank D. Newbury, engineer for the Westinghouse Electric & Manufacturing Company.

The discussion was opened by E. H. Martindale, sales engineer for the National Carbon Company of Cleveland who called attention to the distinction which should be made between the hardness and the abrasiveness of motor brushes. "Soft graphite" is a misnomer, as a brush need not be soft to be non-abrasive. Every increase in commutator speed has been accompanied by improvement in brushes.

H. R. Summerhayes, assistant engineer lighting department of General Electric Company, considered that flickering is the greatest limitation for small plants, where voltage drops result from load fluctuation. This is not so important in large plants when a single elevator forms only a small proportion of the total load. He questioned the author's theory explaining voltage "dips."

Gano Dunn, president of J. G. White & Company, stated that such an excellent compendium should also include an account of F. W. Young's method of adding one, two or three "dead" brushes to bring about sparkless commutation. In theory this principle is superior to the condenser pole tip design or lead resistance methods of killing sparks. It employs the contact drop of the brush, which is usually considered a disadvantage, almost as a counter-electromotive force. In practice the extra brushes do not wear evenly, and so do not give the same contact pressure. When this difficulty is overcome, the principle should meet with a wide application.

D. B. Rushmore, chief engineer power and mining department of General Electric Company, stated that Mr. Lamme's analytical discussion of design in a field of so many variable quantities and empirical equations was almost an endeavor to accomplish the impossible.

While design is interesting the test is in use. Purchasers are interested only in results. Direct current apparatus is destined to greatly increased use and the modern necessity of efficiency and economy demands that things be run at their limit, some of which are here well defined.

In closing the discussion Frank D. Newbury, in order to refute some of Mr. Martindale's statements, said that the advantage of the graphite brush resided not so much in its softness as in its greater current carrying capacity. Impregnated carbon brushes are not satisfactory. The permissible peripheral speed depends not so much upon the brushes as upon the mechanical design of the commutators. Mr. Dunn's contribution he thought excellent, but with regard to the disadvantage of contact drop the disadvantage lay not in the drop but in the fact that the contact drop does not increase rapidly with increase in current. He agreed with Mr. Rushmore that commutation is still more of an art than a science.

Automatically Controlled Substations.

E. W. Allen and Edward Taylor defined an automatically controlled as distinguished from a remotely controlled substation, and analyzed the duties of the attendant in the starting, loading and shutting down of apparatus in hand operated stations. The changes in the conditions of the electric circuit which the attendant observes may also be utilized to operate control relays, and as reliable devices are already available to protect the machines against overload and runaway, his assistance in these matters is no longer necessary. The paper then proceeded on the assumption that converting apparatus should be automatically controlled and that the conditions which have heretofore governed both the design and location of substations can be modified to advantage in many cases. It advocated a reduction in size and an increase in the number of stations and endeavored by example to show the large saving in feeder copper which the proposed arrangement permits. Finally, a description was given of the automatically controlled substations installed on the lines of the Elgin & Belvidere Electric Railroad.

In the absence of Mr. Allen and Mr. Taylor this paper was read by C. W. Place, district engineer General Electric Company at St. Louis.

A. H. Babcock, consulting electrical engineer, Southern Pacific Company, questioned the saving that could be accomplished by the automatic station. H. R. Summerhayes suggested that the automatic insertion of resistance instead of frequent circuit-breaker operations had proven successful in railway substations. While automatic substations do away with a number of operators, they require expert inspectors, so that the operating expense is not entirely eliminated. A considerable saving is made in cold climates because it is not necessary to heat the automatic substations. The relays should be absolutely reliable and capable of handling frequent fluctuations in loads. He agreed that there should be a great future for the application of automatic substation.

In closing the discussion Mr. Place showed that a material saving resulted if the operator's wages at $50 a month were compared with the cost of power for operation at 5 mills. A further advantage accrued from the ability to locate railway substations in congested districts. He agreed that the use of resistance instead of circuit breakers would be of benefit in handling rotaries or motor generator sets. The future of this type of station is dependent upon a standardization of all its parts.

Standard Marine Electrical Installations.

H. A. Hornor briefly cited the requirements of merchant and naval installations. The rules of the classification societies were reviewed and present practice fully discussed. Then followed the specific applications to a number of different types of ships including both merchant and naval vessels. The reasons for the application of electric propulsion to a battleship were briefly given.

As Mr. Hornor was absent, the paper was read in part by John H. Finney of the Aluminum Company of America.

S. H. Blake, engineer with supply department of General Electric Company, after citing his experience in the navy ten or twelve years ago, stated that he noted with pleasure the great improvement in recent methods. At that time 80 volts was the standard, incandescent lamps gave much trouble as did also the voltmeter of the range finder, whose mechanism would be injured by the jar and concussion.

MARINE AND LIGHTING SESSION.

Electric Lighting of Railroad Cars.

R. C. Lanthier dealt with the axle generator system of electric lighting for steam railroad cars, and described recent improvements in control systems for obtaining proper voltage from the generator under all conditions and proper regulation of battery charge to conserve the life of the storage battery. Methods of control depending upon voltage of the battery have not been wholly successful. Since the beginning of 1914 extensive use has been made of systems of control of the battery charge based upon actual input and output in ampere hours, and one such system, which has proved successful, was described.

In the development of the system of control by ampere hour meter, tests were made by means of a special graphic recording ampere hour meter which gives a complete record of the treatment received by a storage battery with any axle generator system. Actual records from long runs were reproduced, to show the results obtained in the operation of the system of control of charging by ampere hour meter. With this system the battery has minimum work to do, in most cases operating between points of 75 or 80 per cent of full load and full charge, and the lighting load is put on the generator as much as possible.

The author not being present, the paper was presented by A. J. Anderson of the Sangamo Meter Company.

Geo. R. Murphy of the Electric Storage Battery Company contributed an excellent written discussion, supplemented with lantern slides, showing the circuits of the generator and control apparatus, for car wheel driven apparatus and curves illustrating the characters of operation. The Electric Storage Battery Company has over sixty such sets in successful operation on cars of the Pullman Company. Battery charging by the constant voltage method is much more satisfactory than by the constant current method. The necessary over charging of batteries is a function of the time and not the amount of work performed.

A. J. Anderson stated that his company had recently devised a method of caring for the battery when idle by using a thermo-couple which causes the ampere hour meter to creep the necessary amount.

C. S. Hull of the General Electric Company's standardizing laboratory questioned whether a 60 ampere meter would record accurately to within one ampere.

A. J. Anderson stated his experience had demonstrated that the meter performance of the new meter was better than that, as a condensite chamber had replaced the shellacked chamber formerly employed to hold the mercury, the shellac making the meter dirty.

ELECTROPHYSICS SESSION.

The Effect of Transient Voltages on Dielectrics.

F. W. Peek, Jr., after showing that failures of dielectrics are generally caused by transient voltages, emphasized the practical importance of determining the various phenomena affecting the strength of dielectrics and means of protecting them when they are subjected to known transient voltages. An impulse generator from which impulse voltages of any given wave front, length of tail, etc., can be obtained was described.

Energy is required to rupture gaseous, liquid and solid dielectrics; this introduces a time element. Thus, on account of this time lag, when voltage is applied at a very rapid rate, as by an impulse, spark-over does not occur when the continuously applied break-down voltage is reached. The voltage "over shoots" or rises above this value during the time rupture is taking place. This excess, or rise, in voltage above the continuously applied break-down value is greater the greater the rate of application. The time depends upon the nature of the dielectric, the dielectric field, the shape and spacing of the electrodes, initial ionization, etc.

The strength of air between spheres and needles for impulses of different front, length of tail, etc., was given, as well as the time in micro-seconds and the voltage required to rupture air between spheres and needles on the front of waves rising at various rates.

Transient spark-over and corona voltages for wires, surface spark-over, insulator spark-over, effects of polarity, air density, practical application, etc., were given. Transient spark-over voltage and time were recorded for oil, and various solid dielectrics. The general laws of breakdown of dielectrics by transient voltages were summarized.

In opening the discussion on Mr. Peek's paper, J. C. Clark, assistant professor of electrical engineering at Stanford University, described Professor Harris J. Ryan's recent experiments in placing a tuned oscillating circuit in a high frequency field in series with adjustable inductance and capacity. By means of a shunted needle gap many of Mr. Peek's statements could thus be experimentally verified.

E. E. F. Creighton, consulting engineer General Electric Company, emphasized the value of these definite figures in lightning arrester work. They explain why lightning discharges go by the spark gaps into the apparatus. They are also valuable in testing insulators.

Percy Thomas, consulting engineer at New York, called attention to the fact that at high frequencies the spark-over seems to be about the same on wet and dry insulators. He showed how the actual voltages at spark-over could be calculated and asked if it were feasible to get a direct measure of electrostatic field density by using some such a device. Insulators should have the power of choking back such surges.

R. W. Sorenson, professor of electrical engineering at Throop Polytechnic Institute, Los Angeles, inquired if any voltage would break down insulation in time. He suggested the term "ionic culmination" as being preferable to ionic saturation and asked whether heat did not have a great influence in shattering insulators.

F. F. Brand of the General Electric Company's transformer engineering department, contributed a written discussion showing that failures by puncture are due to transient voltages.

In closing the discussion, Mr. Peck confirmed the fact that flash over at high frequency is approximately at the same voltage for wet and dry insulators. With 60 cycle current the calculated voltages checked to within 2 per cent of measurements by the sphere-gap. Breakdown will not occur in time at any voltage, as a certain critical gradient must be reached to produce ionization by collision. Heating has little to do with insulator breakdown.

Arc Phenomena.

A. G. Collis demonstrated that increasing developments in electric transmission systems impose correspondingly increased duties upon switchgear, and therefore a study of the arc phenomena accompanying the rupture of circuits in oil switches becomes of growing importance. The paper described a number of experiments made to determine the influence of differently shaped arcing contacts upon the disturbances following rupture of an a.c. circuit, and various theoretical considerations are discussed with a view to modifying the design of oil switches so as to increase their rupturing capacity and thereby eliminate auxiliary devices with their added complications and expense. The use of reactors was also considered in connection with the rating of oil switches.

H. O. Merriam of the University of Toronto showed section of moving picture films of arcs which did not conform with those shown in Mr. Collis' paper, pressures being as high as 500 lb. per sq. in.

L. T. Robinson criticized author's attitude on multiple brick and resistance, introducing switches. He also questioned the statements about quick-acting switches. A slow-acting switch is better for interrupting current after it has decreased to value easy to rupture. Magnetic blowouts do not cause rise in e.m.f. of line.

R. D. Peaslee pointed out that the author's measurements were of force and not of pressure, being in no way similar to Prof. Merriam's. Furthermore, as regards magnetic blowouts the author's oscillograms were taken of the resultant wave across the switch and not of the line e.m.f.

Skin Effect in Conductors.

A. E. Kennelly, F. A. Laws and P. H. Pierce presented the results of about one hundred series of tests, each covering a range in frequency up to about 5000 cycles per second, on the impedance of long loops of parallel conductors of different metals, sizes, and cross-sectional forms. The measuring apparatus was detailed. The theory of the skin effect in solid rods and in indefinitely wide flat strips was worked out in a new and simplified form.

In the absence of the author, this paper was presented by C. L. Cory, professor of electrical engineering at University of California.

L. P. Ferris, engineer with the American Telephone & Telegraph Company, called attention to several features of practical interest and emphasized the value of such investigations in giving definite infor-

mation and tabulated data on a subject concerning which little is known.

VALUATION OF PUBLIC UTILITIES SESSION.

Inventories and Appraisals of Properties.

C. L. Cory, professor of electrical engineering at University of California, classified the object of appraising a public utility as being to determine the investment, the original cost, the cost of reproduction new, the reproduction cost or the present values. Each of these several purposes require different inventories and appraisals which are briefly detailed.

Philander Betts, chief engineer of the New Jersey Public Utility Commission, contributed a written discussion on the subject of overhead charges, concluding that reasonable overhead charges should be included in all valuations of public utilities.

W. G. Vincent, Jr., valuation engineer with the Pacific Gas & Electric Company, showed that the necessity for a valuation is due either to issuance of securities, sale of property, securing franchise extensions, fixing rates, allocation of property in establishing a system of accounting or as a basis of taxation. He outlined the several steps necessary in obtaining such valuations and emphasized the importance of keeping appraisals and inventories up to date.

William J. Norton of the Chicago Commonwealth Edison Company dwelt upon working capital as an essential factor in valuation for rate making purposes. He demonstrated that a certain amount of capital is continually tied up because of the delay in paying bills, average open account, merchandise supplies, fuel reserve and minimum cash balance. He urged that this principle be recognized by courts and commissions.

Henry Floy, consulting engineer at New York, also contributes written discussion on working capital.

A member of the New York State Public Service Commission contributed written discussion concerning rules for calculating, computing and compiling data.

President J. J. Carty warned engineers against quoting court decisions, which may all be divided into two classes: (1) those cases in which the property might be confiscated if the rates were not sufficient; and (2) those cases in which it was necessary to decide whether the rate was fair. Engineers can merely point out the just, fair and right way for the courts to pass final judgment. Lawyers and the public are beginning to appreciate the necessity of absolute fairness in dealing with these problems.

J. T. Ryan, valuation engineer with J. G. White & Company, cited a number of specific instances where properties could not be evaluated by the reproduction cost method. Fixed rules generally lead to absurdities.

F. Emerson Hoar, rate expert with the California Railroad Commission, stated that "historical plant values" should be determined, not from present prices, but from "historical prices" in order that actual cost may be obtained. Unless one of two methods be adopted before beginning the work, either the cost to reproduce the service or the cost based upon the earning power of the company, the appraiser will be reasoning in a circle as regards rate and value.

J. B. Fisken, superintendent of light and power for the Washington Water Power Company, advocated that non-operative property be eliminatd from working capital, capital for a "jobbing business' being included in this class. He inquired as to what constitutes confiscation. An exhaustive inventory, in his opinion, is unnecessary unless there be water in the stock.

John H. Finney, inquired whether "eight per cent on the investment" applied to the gross.

D. B. Rushmore believed that manufacturing companies will eventually be regulated by a Federal trade commission. With regard to fundamental principles of procedure be suggested that an ample factor of safety be allowed, that rewards be given for efficiency, that the Institute be made a clearing house for ideas on the subject, that working capital be allowed sufficient margin and that exact mathematical analysis cannot be applied in determining manufacturing costs or utility costs.

L. S. Ready of the California Railroad Commission, inquired as to what items should be included under "cost to reproduce new." To what account should commissions and discount on bonds be charged?

In closing the discussion C. L. Cory appealed for proper valuation methods based upon broad principles. The electrical business depends for its success upon giving the best service for the least cost.

TELEPHONY AND TELEGRAPHY SESSION.

Submarine Cable Rapid Telegraphy; Ocean and Intercontinental Telephony.

Bela Gati stated that the speed of cable telegraphy is not satisfactory; the slow work makes the cabling very expensive. The direct current impulses are lengthened on a long cable, because the long cable vibrates with its own natural frequency, which is very low. The impulses of the direct current overflow, over a certain limit. Alternating currents do not suffer such overflowing. The oldest form of the alternating current application is the inverse current. Especially Picard and Gott attained good results with their inverse current systems. Another direction for increasing the speed of the cabling is worked out by the various cable relays; Gulstad's, Muirhead's, Heurtley's and S. G. Brown's relays were discussed. The speed is not yet doubled by the aforementioned relays. The attempts with the high frequency system on ordinary cables were discussed and the theory of the resistance of the cable given, different cables being taken into the computation. The cable rapid telegraphy is solved by the inductive shunts with little resistance. The problem is nearly the same also for ocean telephony; the difference is, that for common telephony various frequencies must be transmitted without distortion. The ocean telephony with aid of high frequency currents on improved cables is already a solved possibility.

For connecting continental circuits strong current microphones, more sensitive receivers, improved single-wire loaded circuits and telephone relays can be applied, which remove every limit of ocean and transcontinental telephony.

President J. J. Carty suggested that the technical nature of Mr. Gati's paper called for written discussion wherein Mr. Gatin should be corrected as to his many misapprehensions of American practice.

Los Angeles Automatic Telephone System.

W. Lee Campbell narrated some of the history and described the present automatic switchboard telephone system in the City of Los Angeles. He described how the system which began to give service with one manual switchboard in 1902, has gradually been extended and transformed through several interesting stages of combined automatic and manual operation, until it now comprises 15 automatic offices and a traffic distributor switchboard which serve a total of 60,000 subscribers stations—the largest automatic switchboard system in the world.

The layout of central offices in the present plant was shown in contrast with the layout of offices in the Bell tele-

phone plant of approximately the same size, operating in the same city.

The traffic distributor switchboard used for handling the outgoing calls from a large number of private branch exchange switchboards is the largest board of the kind in operation, includes thirty operators' positions and handles a heavy traffic. A general explanation was given of the equipment of the board, methods used in operating it and of the economies realized by means of it.

Specially interesting and important features in handling the telephone business of a large metropolitan area like Los Angeles are the methods used in caring for calls for time and for information concerning subscribers' numbers, addresses, etc., and for answering subscribers' complaints and calls for long distance connections. All of these methods were discussed at some length.

The paper closed with a concise statement of the practice of using standards of adjustment and performance for securing uniformly good service from the automatic apparatus scattered over this area of about two hundred square miles and handling from 500,000 to 600,000 calls each week day.

Mr. Leo Keller, chief engineer for the Home Telephone & Telegraph Company of Los Angeles, described how the system was cut over from manual to automatic service without changing telephone numbers or interrupting the service in any way.

Inductive Interference.

A. H. Babcock, in behalf of the joint committee on inductive interference, reported on the progress of the investigations during the past year, their present status and plans for the future. By means of a 37 mile power circuit and private telephone line of the Pacific Light & Power Company, near Los Angeles, together with several banks of transformers and the regular equipment of instrument transformers and portable laboratory, extensive tests were made along various lines which are presented in the report as follows:

The unbalances to ground of a power circuit isolated from ground. This study was undertaken with reference to the residual voltage caused by such unbalances and the effectiveness of transpositions as a means of balancing the system. The conductors of the circuit used for the experiments are spaced five feet apart in a vertical plane. Tests were made under three conditions of the power circuit as regards transpositions; (1st) no transpositions, (2nd) two transpositions dividing the line into three equal sections, or one barrel, and (3d) five transpositions dividing the line into six equal sections, or two barrels. Under each condition, tests were made consisting, in part, of residual voltage measurements with the line energized at approximately 28 kv. between wires, by a bank of transformers isolated from ground; and, in part, of measurements of capacitance and conductance unbalances to ground of pairs of conductors at frequencies ranging up to about 1000 cycles per second. The influences of connected apparatus and of leakage under wet weather conditions were considered. As might be expected, the results of the residual voltage measurements at the fundamental frequency (50 cycles) showed no difference in the effectiveness of two over one barrel for this length of line. In the absence of a source of three-phase energy for frequencies ranging from 200 to 1200 cycles it was necessary to resort to an indirect means of determining the residual voltage at these frequencies. Measurements of the unbalances between pairs of conductors, supplemented by measurements of the total admittance to ground of different combinations of conductors, afford means of computing the residual voltages. The results of these tets at high frequencies showed a marked difference in the effectiveness of the one and two-barrel systems; two barrels being, of course, better than one with the advantage increasing at the higher frequencies. It is interesting to note in this connection that the non-transposed condition of the line gave better balance at the highest frequencies than at the lowest. A point was reached when the gradual decrease of the unbalance with no transpositions and the rapid increase of unbalance with a single barrel resulted in a worse unbalance for the single barrel than for no transpositions. The question naturally arises in the minds of some, as to the reason for tests at such high frequencies where the fundamental operating frequency is only 50 or 60 cycles per second. It has been repeatedly stated and shown that the harmonics rather than the fundamental frequency components are the basic cause of disturbances in parallel telephone circuits. The practical goal of all this work is the determination of reasonable requirements of transpositions in power circuits isolated from ground as a means of obtaining effective electrostatic balance and thereby preventing harmful residual voltage.

Parallel with the experimental work, a theoretical study of the unbalances characteristic of different circuit configurations was carried out. Consideration was also given to the equivalent unbalances of a line at high frequencies.

The relationship of triple harmonic residuals to the magnetic density in grounded star connected transformers. This study included tests with both delta-star and star-star connected transformers. Since the reaction of the line is a factor in determining the residuals introduced by a given bank of transformers the investigation included tests of the influence of different line conditions.

The magnitude of triple harmonic residuals as affected by transformer connections. The comparisons were made at approximately constant magnetic density. The connections considered included star-star, delta-star, delta-interconnected-star, star-interconnected-star, and the effect of an auxiliary bank of delta-star or delta-interconnected-star transformers so connected as to act as a shunt to the line for the triple harmonic residuals introduced by the main transformers.

Induction between the power and telephone circuits. The close and uniform association of the two circuuits, the two being carried on the same poles, afforded an unusual opportunity for a experimental determination of the coefficients of induction and a comparison with computed results, and for testing the effectiveness of transpositions in both the power and telephone circuits as means of reducing inductive interference.

Tests of induction at the fundamental operating frequency of the system were made by energizing the power circuit through transformers under conditions favoring in turn the predominant effect of: (a) balanced voltages, (b) balanced currents, (c) residual voltages, and (d) residual currents. The corresponding induction in the telephone circuit was measured simultaneously with the currents and voltages of the power circuit. As the induction from the balanced components of voltage and current is dependent upon the transpositions in the power circuit, these tests were carried out under the three previously mentioned conditions of power circuit as regards transpositions.

The effectiveness of transpositions in the telephone circuit as a means of reducing induction arising from the several components of power circuit voltages and currents, was tested on a short section of the line which contained no power circuit transpositions.

In a short section of the "parallel," with both power and telephone circuits non-transposed, an extensive series of measurements of induction was made using many combination of conductors and methods of energizing the power conductors. The effects of shielding were studied to a limited extent.

With a single-phase source of energy at high frequencies (Vreeland Sine Wave Oscillator) measurements were

made of the coefficients of induction corresponding to harmonic residuals of high frequencies, and the effect of telephone transpositions, as a means of minimizing induction from such sources, was studied. The lack of a three-phase source of energy at high frequencies prevented the doing of any experimental work to determine the effectivness of power circuit barrels of different lengths on the induction from the higher harmonics of balanced currents and voltages.

The computed coefficients of induction were in very close agreement with those experimentally determined. As a basis for the computations of induction from residual current it was necessary to determine experimentally the depth of the equivalent locus of earth currents. In general, the study of induction and of the effectiveness of power and telephone circuit transpositions, while not being as complete as might be desired, owing to the lack of some apparatus and the fact that only one telephone circuit was considered, has given results of considerable value.

The effect of a ground on one phase of a normally isolated system in producing abnormal residual voltages and currents was studied both experimentally and theoretically with close agreement in the results. Under the abnormal conditions of a ground on a power circuit it is, of course, the resulting residual currents and voltages which cause the greatest damage to parallel communication circuits.

Observations of the residuals of the 15 kv. network (Pacific Light & Power Corporation) which supplied the committee's temporary substation and field laboratory, were studied under two conditions of operation of the power system.

In addition to the San Fernando work there has been some work done on a study of the residuals under operating conditions at several points on grounded neutral networks. The objects of these tests was to obtain information as to the magnitude of residuals to be expected under different typical conditions of operation so as to afford a basis for future recommendations as to the limitations of residuals of this type of system.

During the past year a considerable amount of work has been done on several problems by the telephone companies at the request of the joint committee. The American Telephone & Telegraph Company has conducted extensive tests to determine the detrimental effect, on the intelligibility of conversation, of extraneous currents of different frequencies in a telephone receiver. A report of the results obtained, for single frequencies, has been submitted to the committee and work is now under way with reference to the effect of multiple frequency currents of different combinations. The important bearing of this work was indicated in the discussion submitted by this committee, at the Deer Park Convention, on the subject of irregular wave forms.

Subsequent to the issuance of our report last year, the matter of the redesign of its standard telephone transposition system was undertaken by the American Telephone & Telegraph Company, in order to facilitate compliance with the committee's recommendations in regard to transpositions within the limits of parallels. The present standard system of telephone transpositions affords very limited opportunities for co-ordination with power circuit barrels of different lengths, to make the power and telephone circuits mutually non-inductive. For this reason, the redesign of the telephone transposition system to permit of more flexible arrangements in combination with power circuit barrels was made necessary. This modification of the telephone transposition system applies both to the standard sections and, to the short length sections. A large amount of work is involved which has not as yet been entirely completed.

At the request of the joint committee, the Pacific Telephone & Telegraph Company has submitted a report dealing with the development of balance of telephone circuits. This report is the result of an investigation of the methods and measures employed by the telephone companies to obtain good electrical balance of their circuits and to protect them against inductive interference from other telephone circuits (cross-talk) and from foreign sources. The report considers the subject from the conditions presented by the earliest experience of the telephone companies to those of the present day. This report was desired as a basis for the consideration of the subject by the committee.

The committee has recently been giving careful attention to the matter of future work. There appears to be no good reason for deviation at this time from the general program as laid down in the committee's report published last year. It is expected, therefore, that the future work will continue, as has the work during the past year, along the general lines suggested by that program. The detailed plans for the conduct of this work have, however, been the subject of much discussion. The facility with which the work at San Fernando could be carried out with both power and telephone lines completely at the disposal of the committee at all times, suggested the possibility of test lines constructed primarily for experimental purposes. Were necessary funds available, tests of great value could of course be carried out under such conditions. After carefully weighing all questions involved, it was decided that the information desired could be obtained most advantageously by a study carried out under practical conditions. In any event the committee could not, in justice to itself, properly call its work complete without actually applying in several cases the remedial measures which it proposes and noting the difficulties and limitations imposed by practical conditions.

The problem offered by any case of parallelism between power and communication circuits is capable of subdivision into two main parts. These are, first, the matters of line configuration and co-ordinated transposition systems to render the power and communication circuits as nearly as practicable mutually non-inductive, and second, the control of residuals and their restriction to frequencies and magnitudes which do not cause material interference either to grounded telegraph circuits or to properly transposed and balanced metallic telephone circuits. Normal operating conditions on the power system are assumed.

With reference to the first subdivision, the problem is identical for both the isolated and the grounded neutral types of power system. The second, control of residuals, differs entirely with respect to the two types of systems. For the isolated system the principle is relatively simple. Transposition of the circuit involved in the parallel, throughout its entire length, so as to obtain good electrostatic balance offers the most practical way of accomplishing the result desired. Assuming a uniform configuration throughout the line, the transpositions for this purpose must be so located that each conductor of the circuit occupies all of the conductor positions for equal distances. In other words, they must be equally "exposed" to the earth. In addition, the transpositions must be frequent enough so that their balancing effect is not rendered ineffective by the attenuation and phase changes which occur along the circuit at frequencies producing harmful interfence to the communication circuits. With reference to grounded neutral systems, the control of residuals presents a more complex problem, especially on existing systems. Its solution has engaged the attention of the committee in a large measure from the outset of the investigation and will undoubtedly continue to do so in the future, as this seems one of the main outstanding problems. The residuals of grounded neutral systems characteristically contain the third harmonic and its odd multiples, together with some fundamental and other har-

monic components due to unbalanced load conditions. The solution of this problem, therefore, involves a very careful study of transformer connections, magnetic density, the reaction of lines upon the triple harmonics introduced by transformers, and the interaction of the different banks of grounded star-connected transformers throughout a system. The practical solution of a question of this kind requires tests of typical grounded neutral systems under actual operating conditions. Tests such as were conducted at San Fernando, under the relatively simple conditions where the residuals introduced by a single bank of transformers were studied, afford, however, a good foundation for the study of the more complicated cases to be encountered in practice.

To carry out the plans just discussed, a tentative program, now under consideration, includes the investigation of one parallel involving the isolated type of power system and several parallels involving the grounded neutral type of power system. It is felt that the study of an isolated power circuit, as conducted at San Fernando, supplemented by one other investigation involving this type of power system, will afford the committee all the information necessary for it to establish, on a firm basis of scientific fact, the requirements for transpositions to give good electrostatic balance on power circuits isolated from ground, and thereby prevent residuals of harmful magnitude. The complex conditions encountered on grounded neutral systems make it inadvisable that general conclusions be drawn from an investigation of a single case.

It was said above that theoretcal study has been made of the effect of power circuit configuration on the electrostatic balance of the circuit. It is proposed also to study the effect of circuit configuration on the induction between power and communication circuits. Some work along this line has already been done, especially with reference to possible alterations in configuration of telephone phantom circuits. In general, if it is possible to make power and telephone circuits mutually non-inductive, to a satisfactory degree, by a reasonable number of transpositions installed for this purpose, it is not expected that the question of configuration for either class of circuit will become of controlling importance. Configuration of both classes of circuits will be considerably influenced by other reasons; economical methods of construction for both lines. Other things being equal, it is very desirable that circuit configurations be such that the coefficients of induction between non-transposed sections of lines shall be as small as possible.

A study of the variation with frequency of the effectiveness of transpositions in both power and telephone circuits has been suggested. Under practical conditions there are, however, many other factors, such as length of parallel, large number of telephone circuits involved and points of discontinuity within the limits of the parallel, which enter into the problem of determining the proper number of transpositions in both types of circuits. These factors are such as to enforce arbitrary and somewhat inflexible limits, so that this matter of frequency is not the determining factor in setting a limit for the number of transpositions required to obtain mutually non-inductive conditions. The effectiveness of transpositions at high frequencies was one of the chief questions proposed for experimental investigation on test lines. Such an investigation would be of undoubted scientific interest, but the practical bearing of the subject does not seem to warrant the expense involved, especially as it is expected that the results can be obtained more economically by theoretical study.

Upon completion of the work which has just been discussed, the committee expects to draft a supplementary report to be presented to the railroad commission of the state of California, giving in detail the conclusions derived from its investigation from the date of its first report, and such recommendations as it feels necessary to make the rules recommended in the former report more complete and explicit than was possible at the time the earlier report was rendered.

During the past year $7200 have been raised by contributions of the power and communication interests. Previous to this, $9400 had been raised by a similar contribution made shortly after the formation of the committee. It should be noted in this connection that this amount of money represents only a small portion of the total expended on the investigation. Both the power and communication interests have in addition to the above, contributed heavily in the time of their employes and in apparatus placed at the disposal of the committee. This has been true particularly of the telephone companies. The railroad commission of California has also contributed financially, and the railroads of the state have contributed through the provision of free transportation for all committee members, employes and freight. From the outset, the investigation has had the support of communication interests with more than state-wide affiliation. On the other hand, upon the power interests of California has fallen almost the entire burden of meeting the power interests' share of the expense. Of late there has been considerable discussion among the California power interests with reference to obtaining the financial support of the similar interests throughout the country. This subject is undoubtedly of far more than local importance and it is to the interest of all parties that the investigation thus began be brought to a state of reasonable completeness. The organization and equipment of the committee and the unrivaled field for investigation offered by the conditions in California render it desirable that the work be prosecuted to a conclusion in this state. It is the hope of the Joint Committee on Inductive Interference to bring its study, which involves the mutual relationship of the two largest subdivisions of electrical industry, abreast of the present state of development in each of the two arts involved, electrical energy supply and electrical communication. Beyond this point we can not reasonably go; further progress will occur naturally with the evolution of the two arts. We believe that this result can be attained in such a manner as to leave both unfettered in their development. This, as we undoubtedly all agree, broad-minded public policy will demand.

In calling for discussion on the report President J. J. Carty stated that it represented the ideal way of meeting such difficulties. The work represented a sincere effort to develop the truth and bring about harmonious relations between the power and the telephone interests.

A. J. Bowie, electrical engineer at San Francisco, stated that the report indicated the desirability of keeping away from high frequencies on power lines so as to minimize the trouble on telephone lines. He presented oscillograms and proof from a German engineer that oil switches caused more serious high frequency disturbances than air switches, particularly when equipped with horn gaps, the tests having been made by short-circuiting a 10,000 kw. generator. The curves show a more gradual rise of voltage and of less magnitude with air-brake than with oil-brake switches. Mr. Bowie suggested that the lack of definite data on the subject of arcs in air requires that further investigations be made before any rules or regulations on the subject are enforced.

J. B. Fisken, superintendent of light and power for the Washington Water Power Company, requested a definition of a "parallelism," as a misun-

derstanding of this term may work a hardship on the power companies. In a series of oscillograph tests the Washington Water Power Company had found that the higher frequencies were not as common with air-break as with oil-break switches. He inquired whether the committee had made any investigation of the effect of killing a charging current on a power line. He suggested that the "bat" which occurs when it was killed might be due to the condenser discharge from 2000 insulators on their line. A partial solution to the trouble had been obtained by switching on the low tension side.

J. E. Woodbridge, engineer for Ford, Bacon & Davis, at San Francisco, stated that his experience with oil switches would indicate that inductive interference was due to the fact that the several switches on a three-phase line, being independently operated, did not open simultaneously. Consequently the ruling had been made that there should be a mechanical interconnection between the phases of a switch. This disturbance with oil-break switches is a small measure of what is to be found in air-break switches, which require several hundred cycles to operate as compared with the one or two cycles of oil-break switches. The three air arcs do not break simultaneously, thus giving an unbalance, presumably to a much greater degree.

J. P. Jollyman, engineer of electrical construction for the Pacific Gas & Electric Company, stated that this study has pointed out from the power standpoint that the things causing the most trouble are not essential to the operation of power circuits. Consequently the power companies should reasonably be expected to get rid of the non-essentials which harm other people. As the power frequencies of 25, 50 and 60 cycles are much below telephone frequencies, their inductive effect is not so troublesome as from high frequency harmonics which creep into a power system. The first problem facing the committee is the control of frequencies in the power system. He suggested that transformer magnetizing currents might be eliminated by a new system of transformer connections. A matter of great concern is to find out which forms of line construction and transformer connections are preferable, as he suspects that some are better than others. It is necessary to find out how circuits may be mutually built to give the least interference.

E. E. F. Creighton stated that it is impossible to compare oil break and air break switches without defining the circuit conditions. An oil break makes sharper and greater disturbances on unbalanced lines, but if transformers are connected so that their natural inductance balances the line capacitance the break takes on a different character. Due consideration should also be given to the phase relation. Continuous interference has come especially from the third, fifth and tenth harmonics (11 or 13 and 17 or 19), which proper transposition will remove. A solution will shortly be found for these conditions of continuous induction and in cases of switching on ungrounded neutral circuits. But conditions due to transients from lightning and similar discharges seem hopeless unless it is possible to prevent arc-overs at insulator. The problem is thus more a ceramic than an electrical one and when insulators can be built so that they will not puncture the difficulties may be ameliorated.

A. H. Griswold, engineer of outside plant for the Pacific Telephone & Telegraph Company, was pleased that, whereas the report had first been severely criticized, it was now meeting with criticism of a more constructive character. He urged co-operation among the several interests affected.

P. M. Downing, engineer of operation and maintenance for the Pacific Gas & Electric Company, said that the final report had not been entirely satisfactory to either the power or the telephone interests, as it represented a compromise. The report had been criticized because it was indefinite with regard to such matters as parallelisms. The telephone people had been liberal and were not inclined to fix hard and fast rules as to the distance beyond which interference would not be noticeable. Further investigations may or may not enable a clearer definition to be made. The study had resulted in a better understanding of the mutual troubles and should be instrumental in avoiding future parallelisms.

MINE WORK SESSION.

Deisel Engines for Generator Drive.

Charles LeGrand described some investigations made in Europe of Diesel engines of large capacity, with a view to their suitability for driving generators of 500 to 1000 kw. capacity under conditions prevailing in mining camps in the Southwest.

R. D. Peaslee read the paper in the absence of the author.

Wilfred Sykes, chairman of the mines committee, in a contributed discussion, stated that European apparatus is better made than American. Heavy construction is necessary and the cylinder rating must not be too high. He believes that the steam turbine will supersede the Diesel engine for marine service as the weight is too great and as light engines are not satisfactory.

D. W. Beldon, manager for the Westinghouse Electric & Manufacturing Company at El Paso, Texas, stated that the Arizona plant described in the paper had been operating so successfully that a duplicate equipment had been ordered.

J. D. Peaslee desired to know the kind of operators necessary. Manufacturers should give more data regarding cost of maintenance after two years or more.

A. H. Babcock stated that the maintenance cost would not be high, the main objection being the high first cost.

M. H. Gerry, Jr., suggested that the development cost was partly responsible for the high first cost.

A. H. Babcock stated that European makers offer more reasonable prices, their development charges being spread over a long period. The high pressures necessitate heavy working parts. A high load factor is necessary to absorb the high cost of installation.

H. G. Reist of the General Electric Company had experienced no trouble in getting good operators on the Pacific Coast and in Alaska, any man of ordinary intelligence sufficing, even if he has no mechanical or electrical training.

Various other speakers, including A. H. Babcock, W. D. Peaslee, H. S. Jones and T. R. Landsborough, cited specific instances of successful operation.

Rudolph Tschentscher, electrical engineer Illinois Steel Company, thought that pressure will be reduced in the future as they have in gas engine practice. M. H. Gerry likewise thought that prices would come down.

A Large Electric Hoist.

Wilfred Sykes described an electric hoist recently installed in a mine at Butte, Mont., having a depth of shaft of 4000 ft., net weight of load 14,000 lb. weight of skip and cage, 9000 lb. and maximum hoisting speed 3000 ft. per min. Some results of operations were given. This hoist is of special interest as being the largest electric hoist in the world and containing some important departures from previous practice.

G. B. Rosenblatt, engineer with the Westinghouse Electric & Manufacturing Company, read the paper in the absence of the author.

Graham Bright, engineer with the Westinghouse Electric & Manufacturing Company, in a contributed discussion, called attention to the fact that the hoist had met the specified requirements. He also showed the mechanical limitations in building fly wheels.

Selby Haar, electrical engineer at New York City, who has records of 720 electric hoists, thought that this installation was the largest, but not the most powerful, in America. A larger hoist is operating in South Africa. He discussed changes in the design of fly wheels, and said that the design was limited by the railroad clearance and not the difficulties of manufacture. He questioned placing the fly wheel in the middle of the pit.

F. D. Newbury pointed out the features of design contributing to ease of handling and he emphasized the large factor of safety necessary in the design of the insulation. The fly wheel was placed in the middle of the pit because of better bearing supports and more efficient maintenance of the machine. Railroads can carry wheels up to 15 ft. in diameter.

G. B. Rosenblatt stated that 2150 h.p. was the power input when hoisting 5000 ft., the motor-generator set has a capacity of 2250 h.p. The fly wheel can be placed on the end of the shaft for hoists up to 20,000 lb. capacity, above which load the clutches are difficult to construct.

M. H. Gerry stated that there was a general tendency to replace steam hoists by air and to use light fly wheels.

G. B. Rosenblatt gave the efficiency of an air hoist as 32 per cent and of an electric as 46 per cent. The greater efficiency is not of so much consequence as is the reliability of electric hoisting.

The Modern Electric Mine Locomotive.

Graham Bright stated that the day of the small mine with small equipment is passing, and in the future most of the bituminous coal mining will be accomplished in larger mines using heavy equipment. The demand for larger capacity in equipment has been increasing rapidly of late, and owing to the restricted space available for the equipment on a mine locomotive, difficulty is being experienced in designing equipment to meet the conditions. A possible solution of the problem is in providing forced ventilation for the motors which are of a type that require very little ventilation to produce a large increase in the continuous rating. This scheme has been tried out on a large locomotive and the results indicate that forced ventilation will play a prominent part in meeting the extreme severe conditions that are frequently arising in the mine locomotive field.

G. M. Eaton, engineer with the Westinghouse Electric & Manufacturing Company, in Mr. Bright's absence, read the paper.

Wilfred Sykes wrote that this class of design had been somewhat neglected. Some difficulties had been experienced in cooling the motor.

E. H. Martindale inquired as to the undercutting of the mica in mine motors.

G. M. Eaton stated that the practice had been abandoned. No trouble is being found with forced ventilation.

JOINT SESSION WITH AMERICAN ELECTRO-CHEMICAL SOCIETY.

Treatment of Silver Furnace Fumes by the Cottrell Process.

Chas. A. Aldrich stated that the Cottrell electrical precipitation process had proved successful in recovering practically all metal value from the gases of the Dore furnaces in the Raritan Copper Works. Detailed description was given of the apparatus employed.

In the absence of Mr. Aldrich, the paper was read by J. B. Fisken.

Dr. F. G. Cottrell briefly described experiments now being conducted at the Exposition in dissipating fog by his process, using a 350,000 volt Thordarson transformer. For this purpose a 1,000,000 volt, 1000 kw. transformer is now being installed. It has been found that from 30 to 40 kw. are necessary to disperse the fog in a million cubic feet of gas per minute.

W. D. Peaslee told of some investigations which he had made in the electrical stimulation of plant growth.

Overhead Electrolysis and Porcelain Strain Insulators.

S. L. Foster stated that there is a slight leakage of current from trolley wires to earth through insulated supports on all electrical overhead construction, which if not checked permits a flow of current which gives rise to electrical separation of water into oxygen and hydrogen. The oxygen liberated acts vigorously upon the adjacent metal parts which in time become badly corroded. This electrolytic action also seems to remove the galvanizing from live metal parts before attacking the iron. A partial remedy for this rusting of live galvanized wire is painting.

This electrolytic effect is also seen to take place over strain insulation where the creepage distance is insufficient. This indicates that a creepage distance proportional to the conditions met must be secured to stop the flow of current around the outside of the insulators. The author concluded that, under fog conditions, the insulator surface exposed for creepage is insufficient in our present standard devices.

Another form of overhead electrolytic action noticed in electric railway work is caused by use of dissimilar metals in contact. Sulphuric acid and other fumes in the air, and ozone from a nearby ocean, are supposed to be the electrolytes that set up a local battery action at these points of contact. The logical remedy for this trouble is to use similar metal in contact. The paper then described the troubles encountered in San Francisco due to these causes and the remedies which have been applied.

L. W. Webb, master electrician at the Norfolk, Va., Navy Yard contributed discussion on the electrolysis of wireless antennae, concluding that copper-clad wire and aluminum wire were unsatisfactory for this use. Silicon bronze however met all requirements.

J. B. Fisken told of a galvanized wire railroad crossing which had been in service for twelve years without change. He had found that guy wires on trolley poles were attached. He thought that leakage over the insulators had been caused by smoke.

S. L. Foster suggested that large insulators might obviate the difficulty.

John H. Finney cited an instance of an aluminum line on which no trouble had been experienced for 14 years.

Paul J. Ost, electrical engineer with the San Francisco city engineer's office, said that the municipal trolley line's concrete poles had not been in service long enough to allow any conclusions to be drawn. Galvanized copper wire was used.

Electrochemical Possibilities of the Pacific Coast.

J. W. Beckman, chemical engineer with the Great Western Power Company, briefly summarized the water power resources of the Pacific Coast and listed the raw materials which are available. Details were also given of the possible industries.

A written communication from W. E. Herring, industrial agent Puget Sound Traction, Light & Power Company, described the electrochemical situation in the Northwest. Dorsey Lyons of the U. S. Bureau of Mines also submitted a discussion in writing.

Gano Dunn warned against being led astray by the glamor of water power development, as the cost of steam power is constantly being cut.

John H. Finney called attention to the fact that water power is valuable only when developed.

C. L. Cory emphasized the economic features as being paramount to the engineering aspect. The market for chemical products is uncertain. He prophesied that a three-phase, 175,000 volt line extending the length of California would some day act as a "clearing house" for all power plants. In Norway the initial cost of installation of power plants is $40 per horsepower of installed capacity. The maximum rate for electrochemical purposes should not exceed $12 per horsepower year.

L. T. Robinson, engineer for the General Electric Company, stated that the Pacific Coast was one of the few regions where the chemical plants could be located close to the power plants and thus eliminate transmission costs and losses.

TRANSMISSION SESSION.

Delta-Cross Connections of Transformers.

George P. Roux described two methods of transformer connections, the tee-cross and the delta-cross, showing their application for parallel operation of two-phase and three-phase systems. Clear explanations were given of voltage, current and phase relation, and the dephasing action which take place in each case.

The delta-cross system of connections lends itself to a great number of applications, either for the parallel operation of two-phase and three-phase systems or for the simultaneous supply of two-phase and three-phase power from one bank of transformers. It is to be noted that in this system of connections no special taps are required, except a 50 per cent tap on one transformer (usually easily obtainable), the compensation of one-phase of the system being done externally by means of a small booster transformer.

The simplicity of connections, the feature that no special transformers are required, and no special taps necessary, give the electrical engineer facilities to meet promptly and economically the requirements inherent to two-phase and three-phase simultaneous distribution from only one transformer bank.

Mr. Roux's paper was read by E. E. F. Creighton.

Selby Haar requested further enlightenment on some obscure points in the paper and stated that he found some confusion in the trigonometrical calculation.

W. A. Hillebrand, of the Pacific Gas & Electric Company, stated that this company had employed these forms of transformer connection for at least ten years. Unless core-type transformers are especially constructed for the purpose serious unbalancing will occur, though this can be reduced by cross-connecting the windings.

F. F. Brand presented in writing a general solution of the particular case discussed by Mr. Roux. He spoke of a few of the disadvantages of the form of connection, the most important being that specially designed transformers are necessary.

Harmonics in Transformer Magnetizing Currents.

J. F. Peters showed in a concise manner the cause and effects of higher harmonic currents in magnetizing currents of transformers. A hypothetical case was analyzed to show the cause of the harmonics; then the schemes of connecting transformers that are commonly used for polyphase transformation were taken up and the effects of the harmonics on each case pointed out.

The author also showed the reason why third harmonic voltages are not developed in the three-phase "core type" transformer when connected star-star.

F. D. Newbury presented Mr. Peters' paper.

D. J. Cone of Berkeley pointed out that in a star-star connection of transformer bank the fundamental voltages are in opposition and consequently the triple harmonic voltages are likewise giving a small current flow, the effect being differential and not cumulative. He pointed out several inconsistencies in the paper and urged that a careful distinction be made between the terms exciting current and magnetizing current.

H. S. Osborne of the engineering department of the American Telephone & Telegraph Company, in a contributed discussion, stated that such analytical treatment facilitated the calculation of these phenomena. Although the results indicate the abnormal voltages which occur at resonance, the third harmonic current is usually so slight as to offer little danger.

L. P. Ferris called attention to the importance of considering line reactance on such calculations.

Transmission With Star Transformer Connections.

L. N. Robinson demonstrated the phenomena attending the operation of star-star transformers with grounded neutral on the line side. Contrary to current opinions, the author believes the abnormal voltages and destructive effects, which often accompany star-star operation, are due to even harmonics, at least in a large number of cases. At high magnetic densities, the third harmonic voltage may be appreciable, but the indications are that the even harmonics will cause damage at nominal magnetic densities lower than those which require appreciable third harmonic exciting current.

The data on which the conclusions are based, include approximately 150 oscillogram waves and a correspondingly large number of meter readings were not given.

Prof. Harris J. Ryan stated that the paper is difficult to understand without having the data upon which the author's conclusions were based. J. C.

Clark likewise thought the paper incomprehensible, because unfamiliar phenomena were not explained.

H. O. Stephens of Pittsfield, Mass., told of some experiments whereby he had obtained even harmonics by superimposing an alternating current on a direct current circuit. This condition of even harmonics is frequently encountered in arc furnace work.

W. A. Hillebrand stated that it was due to magnetic saturation and was rather common.

J. P. Jollyman stated that the author's conclusion that it was dangerous to use star-star connected transformers in long distance work, was not true as it is in common use in systems operating with an isolated neutral. If the transmission system has grounded neutral the neutral is stable without the necessity of adding tertiary deltas. Furthermore it is entirely feasible to operate star-star system with no delta connection.

F. F. Brand thought the paper would be more valuable if it stated whether tests were made under stable or transient conditions. It brings out the fact that the three-phase core-type transformer is the only economic type.

Abnormal Voltages in Transformers.

J. Murray Weed treated on the electrical behavior of transformer windings when subjected to steep wave fronts and high frequency wave trains. The dependance of the internal voltages produced, upon the distribution of capacity with the inductance of the winding was discussed.

Practical windings are divided into two general classes, one in which inductance and capacity are practically uniformly distributed, and the other in which the capacity is more or less concentrated at certain points, with relatively concentrated portions of inductance intervening.

Neglecting the effects of the high frequency dielectric losses in the insulation at high frequency, distinct mathematical analysis was given to these two classes of winding to determine the ratios of the internal voltages to the voltage to the external wave or wave train. The resulting internal voltage distributions, were plotted for various frequencies, and curves plotted for the relations of maximum internal voltages to frequency. These curves show that some frequencies are dangerous, while others are not, but it can not be said that one of these types of winding is better than the other from the standpoint of the possibility of excessive internal voltages.

R. W. Sorenson told how serious surges on a 150,000/60,000 volt line had been cured by damping them out by means of transformers tied in parallel.

F. F. Brand said that the paper showed how and why excessive voltages were produced in transformer windings. These oscillations should be dampened out. Surge troubles appear more frequently with lightly loaded lines.

Percy Thomas suggested the instrumentality of electrostatic capacity in causing the troubles indicated by Prof. Sorenson.

Short Circuit Phenomena of Alternators.

N. S. Diamant, first briefly considered the theory and explanation of the electromagnetic phenomena involved in the sudden short circuit of alternators, as given by Berg and Boucherot. He showed how complex the different resistances and reactances are thae enter the equations of sudden short circuits.

New methods were developed for the experimental determination of these quantities by simply determining the rise of direct current in the field and armature circuits. Also new simple methods were given, based on theoretical equations, for the calculation of short circuits directly from oscillographic records.

Data relating to the short circuit of a 45 k.v.a. alternator were given; also an electrical device, designed by the writer and used in most of the tests, for short circuiting a machine at any given point of the e.m.f. wave, as described.

As a whole, an attempt was made throughout the paper to put calculations of sudden short circcuits on a sound retional basis and to test the correctness of the theories given.

F. D. Newbury, abstracted Mr. Diamart's paper which he considered a valuable contribution. He believes that in addition to the calculations suggested by the author tests should also be made so that machines may be designed to withstand short circuits. He urged that the Institute standardize the definition of what constitutes a short circuit.

C. J. Fechheimer, with the power engineering department of the Westinghouse Electric & Manufacturing Company, in a written communication, called attention to the difficulty of calculating such phenomena because it is hard to predict the effect of eddy currents. He also discussed the design of alternator so as to withstand short circuit.

JOINT SESSION WITH INSTITUTE OF RADIO ENGINEERS.

Radio Development in the United States.

R. H. Marriott traced the improvements in the development of wireless telegraphy during the past fifteen years, illustrating his paper with lantern slides. Statistics were given of the number of commercial and government stations in service each year. California was the pioneer in the development of permanent public overland radio service through the work of the Federal Telegraph & Telephone Company. He illustrated the successive types of transmitters and receivers used and told of the increase in the power and the range stations. The patent system and governmental regulation was also discussed.

Sustained Radio Frequency High Voltage Discharges.

Professor Harris J. Ryan and Roland G. Marx of Stanford University, described a number of experiments with high frequency high voltage discharges. Their conclusions show that after such corona brushes are once started they may be maintained at much lower voltages than those required to start them. Their heating and ionizing properties destroy even the most refractory insulations. Their power factor is much lower than that of lower frequencies at corresponding voltage, yet because of the high values of the currents that produce them the losses are very much greater. The high frequency voltage causing discharge is at least one-third the low frequency voltage. When the two forms are combined they will discharge through distances equal to the sum of their effect when discharging singly.

Robert H. Marriott expressed the thanks of the Institute of Radio Engineers for this valuable paper, as it points out the trouble which will ensue when larger stations are built.

F. Rieber said that the paper explained certain difficulties he had experienced in rectifying high tension alternating current for precipitating dust.

Haraden Pratt, T. W. Stone and R. E. Thompson asked a number of questions which were answered by Professor Ryan.

Entertainment Features.

With so many technical papers to be discussed little time was afforded for entertainment. Automobile

rides and lunches had been arranged for the ladies and a number of informal lunches were given to the members. On Thursday, a beautifully appointed dinner-dance was enjoyed by about a hundred and fifty members and guests at the St. Francis Hotel.

On Saturday morning President J. J. Carty was presented with a commemorative medal at the Panama-Pacific International Exposition.

Following is a list of out-of-town registrations, local names being omitted:

Abbey, Frank H., Boston, Massachusetts.
Addicks, Lawrence, Long Branch, New York.
Anderson, Walter J., Denver, Colorado.
Anderson, A. J., and wife, Springfield, Illinois.
Baker, J. E., Bakersfield, California.
Barnes, H. H., Jr., New York, N. Y.
Bass, J. E., Los Angeles, California.
Bawdle, J. W., San Diego, California.
Bradford, P. L., Pleasanton, California.
Beldon, D. W., El Paso, Texas.
Blake, S. H., and wife, Schenectady, New York.
Bowes, Lawrence C., and wife, Chicago, Illinois.
Boykin, R. M., and wife, Chicago, Illinois.
Brand, F. F., Pittsfield, Massachusetts.
Briggs, G. H., Riverside, California.
Brighthill, F. G., Harrisburg, Pa.
Brown, C. A., Seattle, Washington.
Burnham, G. B., Reno, Nevada.
Cadwell, Mrs. F. A., Amherst, Massachusetts.
Carty, J. J., New York City, N. Y.
Campbell, W. L., Chicago, Illinois.
Champagne, Leo., Los Angeles, Cal.
Cheever, Markham, Salt Lake City, Utah.
Coker, F. M., Los Angeles, California.
Colby, S. K., New York, N. Y.
Condit, C. E., and wife, Portland, Oregon.
Cook, E. W., Los Angeles, California.
Coons, J. W., Woodland, California.
Cowles, Jenny L., Amherst, Massachusetts.
Creighton, E. E. F., Schenectady, New York.
Crossman, T. E., New York, N. Y.
Crossman, T. E., New York, N. Y.
Dearborn, R. H., Corvallis, Oregon.
Diamant, N. S., Houston, Texas.
Dibblee, Barry, Minidoka, Idaho.
Dickman, Ernest, St. Helena, California.
Dunn, Gano, New York, N. Y.
Eaton, G. M., Pittsburg, Pennsylvania.
Eustis, T. W., Hinsdale, Illinois.
Finney, John H., Washington, D. C.
Fisken, J. B., and wife, Spokane, Wash.
Furuchi, T., Engineer, Japanese Navy.
Gartley, A., Honolulu, T. H.
Gerry, M. H., Jr., and wife, Helena, Montana.
Greenswall, L. B., Chicago, Illinois.
Greves, G. L., and wife, Cleveland, Ohio.
Haar, Selby, wife and daughter, New York, N. Y.
Harris, Henry, Pittsburg, Pennsylvania.
Hess, E. W., Bishop, California.
Hess, F. M., Bishop, California.
Hendel, C. W., Laporte, California.
Hooper, John, and wife, Winnipeg, Manitoba.
Horinchi, S., Japan.
Horton, R. S., Santa Ana, California.
Hutchinson, F. L., New York, N. Y.
Johnson, Carl E., Los Angeles, California.
Jones, G. Douglass, Sacramento, California.
Kent, P. J., Clinton, Missouri.
Kuhn, George W., Brooklyn, New York.
Landsborough, T. R., Tonopah, Nevada.
Lawton, A. H., Portland, Oregon.
Lebenbaum, Paul, Portland, Oregon.
Lee, Carl, Nokomis, Illinois.
Lissan, O. F., and wife, Schenectady, New York.
Lloyd, M. G., Chicago, Illinois.
Lockwood, Thomas D., Boston, Massachusetts.
Lovejoy, E. W., Los Angeles, California.
McCoy, L. E., Juneau, Alaska.
Manley, Rowland, Chicago, Illinois.
Marriott, R. H., Bremerton, Washington.
Martindale, E. H., Cleveland, Ohio.
Matson, John Jamison, Ithica, New York.
Menefoglio, A., Waiuiha, Kauai, Hawaiian Islands.
Menzin, A. L., Philadelphia, Pennsylvania.
Merrill, A. P., and wife, Provo, Utah.
McDonald, J. E., and wife, Los Angeles.
Moore, W. D., Portland, Oregon.
Monges, R. F., Portland, Oregon.
Montsinger, B. M., Pittsfield, Massachusetts.
Muller, Henry P., Pittsburg, Pennsylvania.
Murphy, John, Ottawa, Ontario.
Muschenhein, Fred, and wife, New York City.
Newbury, F. D., and wife, Pittsburgh, Pennsylvania.
Nissler, Dr. F. R., Fibourg, Switzerland.
Peaslee, W. D., and mother, Portland, Oregon.
Peek, F. W., Jr., Schenectady, New York.
Pierce, H. B., Spokane, Washington.
Peterson, J. A., Warrensburg, Missouri.
Pfund, Richard, New York, N. Y.
Polk, R. W., New York, N. Y.
Pope, Ralph W., New York, N. Y.
Pratt, Robert J., Honolulu, T. H.
Place, C. W., and wife, St. Louis, Missouri.
Potts, Wm. A., Adelaide, S. Australia.
Pyle, C. G., Los Angeles, California.
Quinn, E. A., Fresno, California.
Reid, C. R., and wife, Eugene, Oregon.
Robinson, L. T., Schenectady, New York.
Rice, Calvin W., and wife, New York, N. Y.
Richards, R. H., Butte, Montana.
Robinson, Lloyd N., Los Angeles, California.
Rosenblatt, Gerard B., Salt Lake City, Utah.
Rushmore, D. B., Schenectady, New York.
Reist, H. G., and wife, Schenectady, New York.
Scribner, C. E., and wife and daughter, New York, N. Y.
Scrughan, J. G., Reno, Nevada.
Simonson, G. M., Sacramento, California.
Smith, Jesse M., New York, N. Y.
Sorensen, R. W., Pasadena, California.
Stauffacher, E. R., Los Angeles, California.
Stevens, H. O., Pittsfield, Massachusetts.
Stevenot, J. E., and wife, Manila, P. I.
Stevens, J. F., and wife, Philadelphia, Pennsylvania.
Stone, A. L., Los Angeles, California.
Summerhays, H. R., Schenectady, New York.
Thomas, Percy H., and wife, New York City, N. Y.
Tschentscher, R., Chicago, Illinois.
Warner, E. P., and wife, San Diego, California.
Weber, F. D., and wife, Portland, Oregon.
Weed, J. Murray, Pittsfield, Massachusetts.
Wilhelm, Geo. T., Denver, Colorado.
Wyckoff, H J., Detroit, Michigan.

The strength of electric currents may be accurately determined in absolute measure by means of the Rayleigh current balance, in which the current to be measured is passed in series through two parallel circular coils of unequal radii, one of which is suspended from the beam of a balance. The distance between the planes of the coils is varied until the force of attraction between the two coils is a maximum, and the value of the force is obtained by adding weights to the other arm of the balance until its equilibrium is restored. Since the maximum force obtainable depends on the ratio of the radii of the coils alone, and not on their individual dimensions, it is only necessary to determine further the ratio of the radii of the coils, and this may be done with great accuracy by electrical means. The constant of the instrument, that is, the maximum force per unit current for the coils in question, has been obtained in the past by interpolation between values of the force, calculated for various assumed distances of the coils, in the neighborhood of the critical value for which the force is a maximum. For, although the general formulas of Maxwell and Nagaoka give the value of the force for any two given coils, at any assumed distance with great accuracy, no formula has been heretofore published for calculating at what distance the force becomes a maximum. To supply this lack there is derived in a paper just published by the Bureau of Standards, Department of Commerce, entitled "The Calculation of the Maximum Force Between Two Parallel, Coaxial, Circular Currents," a formula which gives the critical distance as a function of the ratio of the radii. The latter part of the paper is devoted to the development of methods for facilitating the calculations. The formulas are illustrated by numerical examples and tables, and the new formulas are shown to give results in agreement with those derived by more indirect and laborious method of interpolation.

Inductive interference with telephone lines from parallelism with a.c. carbon arc lamp circuits may be practically eliminated by substituting nitrogen filled tungsten lamps for the arc lamps. The tungsten lamp produces practically no distortion of wave shape and the compensator generally used with each lamp damps out such harmonics as may exist.

LETTERS TO THE EDITOR.

Government Control of Water Power.

To the Editor:

Sir:—Referring to the article in your September 4th issue, giving the address of Senator Geo. C. Chamberlain, on the Ferris Bill, the utterly strange thing is that the "selfish interests," i.e., interests that wish to make use of what is now going to waste, do not resent reasonable regulation. The advocates of the Ferris Bill seem to think they are resenting regulation, and that the only way to regulate them is to make their investment insecure. Why do not the Ferris Bill advocates confine themselves to the important facts in the case, or at least the points presented by those who feel they are just as honest and sincere as the Ferris Bill advocates? These points, as the writer understands them, are about as follows:

1st. What reason is there to think that our state commissions will not be able to regulate utility corporations?

2nd. Does even a novice in finance think that the proposed power tax will be only paid by the power company, and stop there?

3d. Consider the fact that the advocates of the Ferris Bill generally have assumed the attitude that they are the "pure article" when it comes to considering the good of the Western States. Has the fact that the East has developed most of its immediately available water power, creating immense industries, and shipping great quantities of manufactured articles out West, any bearing with the Eastern people that want to "regulate" us, i.e., apparently prevent us from developing our resources, so we will have to depend largely on the Eastern manufactures?

4th. Great stress is laid by Senator Chamberlain on the fact that so much power is developed or controlled by large interests. All well informed people, especially engineers, know that operating a large number of plants on one system promotes economy and reliable service. Electric light and power rates are positively the only things on a large scale that have not added their proportion to the high cost of living.

5th. Why subject a corporation to dual regulation? Each regulatory body will have its pet theories to work out, and no doubt they will clash. It has been the experience of the West that they will be ruled by Eastern interests, who will have no sympathy or understanding of the needs of the West. This is true, as Senator Chamberlain admits, that the past laws were put through by the same interests that are now trying to force on the West the Ferris Bill, and which has retarded developments in the West for five years. These interests, whether knowingly selfish, Pharisees, bothered with a beam in their eye or honestly misinformed, have hurt the West, and some Westerners would like to see some constructive measures, and not obstructive acts, in any further attempts to help (?) the West.

6th. Senator Chamberlain says that capital will not invest in enterprises unless it feels that it can do so with safety and with assurance of a reasonable return on the outlay. Then why not state definitely that all investments honestly made will be protected on a fair basis? Why not also state that if the government so wishes it can take over the power plant with all the distributing system that goes to make up the entire system, with all the contracts, at a fair valuation, this valuation to take into consideration past dividends and losses, and money invested? Then if the state and federal regulations now proposed cause a loss, the federal government will have in the end to pay for it. This does not seem like a good provision, but why not try to protect the investor as well as the public? It is a positive fact that if the investment is not secure, the public is the loser, so making the investment secure can only redound to the benefit of the public.

The argument is made by the conservationists that the federal government would not do anything to injure an operating corporation. The only answer to this is that there is evidence to the contrary. Where is our shipping industry? The federal government is apparently helpless to promote it. In fact, they recently passed a bill that has about wiped out the last remaining trace of our merchant marine on the Pacific. The writer's personal belief is that the politicians consider it good politics now to prevent a public service corporation from starting anything that looks as though it might be profitable, and they will never consent to passing any bill allowing our power possibilities to develop unless they have a finger in the pie.

7th. Do the conservationists realize that water power sites are not a gold mine? Water power sites have to compete with various forms of fuel, and there are constant improvements being made that look as if in a few years water power will be less desirable.

8th. The writer firmly believes that a power plant in hand is worth two in the bush. If we have them, we can always regulate them, or condemn them under our laws of eminent domain.

10th. It appears to me that the laws regarding the development and use of water power can be made liberal. Simply because we had a policy that in many cases was abused, is no reason for going to the other extreme and playing the dog in the manger. Practically all the power required for the present needs of the West, except for railroads, is now developed. The future use will have to be developed by settling the country with more people, creating new industries, such as electric furnaces, nitrogen products, electrifying railroads, etc. This is a promising field, and so far no government appears to have been as successful along these lines as individual effort. As a rule, a new industry or invention is developed because the great majority of the people do not think of it or believe it is practical. If Prof. Langley had had private backing instead of federal aid, the aeroplane might have been developed years before it was.

Aerial transportation is now a possibility which is very much desired. Why does not the government spend money developing it? It is being left to private effort, and some day when a fine system of aerial transportation is introduced, there undoubtedly will be a large number of people that will call all aerial transportation companies "robbers," and do everything in their power to harass them.

F. O. BROILI.

Portland, Ore., Sept. 19, 1915.

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N. E. L. A. Repudiation of Ferris Bill

The public policy committee of the National Electric Light Association has emphatically disapproved of the Ferris Bill! The first great step in the campaign of education as to the inadequacy of this measure has now been taken. The representative electrical men of the country publicly recognize its insufficiency. Proper amends have thus been made for the lack of positive expression at the San Francisco convention last June.

The committee met at Spring Lake Beach, New Jersey, on September fifteenth and adopted the following resolution:

In view of the importance of the subject to members of this association and to the general public, the Public Policy Committee of the National Electric Light Association has considered legislative propositions which seek to deal with the control of water power developments in the public domain. The committee is unanimous and emphatic in its opinion that development could not by any possibility be secured through the enactment by Congress of what is generally known as the Ferris Bill passed by the House of Representatives and reported with amendments by the Senate Committee on public lands January 11, 1915. In the opinion of many of our member companies, who are anxious to make large investments, the bill is faulty in principle, while others (whose experience fully qualifies them to testify) insist with practical unanimity that at least further and radical amendment is absolutely essential in order to avoid a continuation of the past policy of repression and economic waste. The committee hopes that during the forthcoming session of Congress definite legislation of a reasonable character will be agreed upon and enacted so that there shall not thereafter be any governmental obstacles in the way of financing, constructing and operating the many developments which are now and for so long have been mere prospects.

This action should be the source of great encouragement to all who are struggling under the heavy handicap imposed by governmental discouragement of water power development. When it has taken this body of electrical men these many months to realize the true state of affairs, is it any wonder that the general public are still fooled by the specious arguments of the bureaucrats at Washington?

Yet, in all fairness to the Forest Service officials, it must be acknowledged that most of them are actuated by the highest motives. They merely do not understand the situation. They are familiar with the waste of timber and fuel, which can be conserved by non-use. They seem ignorant of the fact that water, on the contrary, is conserved only when it is used. Timber and fuel are wasted by use, water power is wasted by non-use.

The men who propose to develop the latent water power of the West are the true conservers of that power. The men who impose needless restrictions upon such development are the wasters. The lack of development of hydroelectric power in the past will be regarded by future generations as the great economic crime of the first part of the twentieth century.

Think of the millions of arid acres in the West that could have been irrigated by the aid of cheap hydroelectric power. Think of the thousands of tons of

coal and barrels of oil which have been inefficiently burned in locomotives hauling cars which might have been electrically propelled. Think of the great fertilizer, pulp and other electro-chemical industries which have not been established because cheap hydroelectric power could not be assured.

The present laws offer neither inducement nor security to investing capital. Monied men agree that the Ferris Bill is but little better. Capital would be available at once if it had confidence in the good faith of those legislators who have it in their power to grant needed relief.

During the present week a conference on this important matter is being held at Portland. There is every prospect that from it will come suggestions for legislation which will in every way protect the public interest and stimulate private initiative in the public service.

Meanwhile it is necessary that every effort be continued to inform the public of the harm that is being done by retarding water power development. The individual citizen is the one who suffers from the lack of industrial activity in his community. These attempts to restrict capital merely drive it into other fields. Likewise it is the individual citizen who will ultimately profit far more than the regulated investor in projects which upbuild the community.

This sane view of the situation was taken by the water power committee of the American Institute of Electrical Engineers in its report to the National Waterways Commission in 1911 and was reiterated in stronger terms in its statement to the Water Power Conference this week. As the services thus rendered by the Institute are of a scientific and professional character, and in no way tinged with commercialism or politics, they carry especial weight in the matter.

The sentiment in which this subject should be approached has been fittingly expressed in a book entitled "Looking Squarely at the Water Power Problem," by Henry J. Pierce of Seattle.

> "At every waterfall two angels stay,
> One clothed in rainbows, the other veiled in spray.
> The first the beauty of the scene reveals,
> The last revolves the mighty water wheels,
> And there those white-robed sisters ever stand,
> Beauty and Utility, hand in hand."

A Plea for Saneness at Conventions

San Francisco is well qualified to speak authoritatively on the subject of conventions. During the current year it is her privilege and pleasure to act as host for over eight hundred organizations who have conjoined the opportunity of their annual meeting with the attractions offered by an international exposition.

Her experience has demonstrated that the true measure of convention success is neither in the number of delegates attending nor in the number of papers presented. This has proven particularly true in the case of the various engineering conventions.

The true function of a convention is to instill in the minds of those who attend it a higher conception of the interests which it represents and to point out the way in which this higher conception may be transformed into terms of every day value and efficiency. Neither of these purposes can be fulfilled by the mere presence of many people and a long list of papers.

On the former score there is no cause for complaint. Most of the meetings have been of a comfortable size and everybody has had a chance to meet everyday else unconventionally at the conventions.

But in the latter case the bounds of reason have been occasionally overstepped, as was exemplified by the Panama-Pacific convention of the American Institute of Electrical Engineers last week. Consider the difficulty of reading and adequately discussing twenty-six papers in the ten hours available in a two days' session.

This stupendous task was undertaken by the plan of parallel sessions. The three-ring circus is not a circumstance in its attention-distracting powers. One man was compelled to submit a written discussion to be presented by another at one session while he was attending to his duties in a parallel session. The chairman of a meeting usually acted as a reactance coil in order to choke off discussion.

Furthermore, a number of papers, while of the highest technical value, were away above the heads of the rank and file of the members who attended the meetings. The papers dealing with specialized questions of design, particularly, could not be properly discussed in a territory where the great majority of the members are interested in construction, operation or evaluation.

This is in no way intended as a criticism of those whose hard labors made possible this otherwise successful meeting. Many of these points had not been foreseen. But it is devoutly to be hoped that the next Pacific Coast convention will limit the number of papers to an average of not more than two for each half day session.

The case of the International Engineering Congress which has been held at San Francisco during the past week is somewhat different as its chief function is to give expression and permanent record for the engineering achievements of the past decade. The printed proceedings are in many respects the most valuable result of such a meeting. There has been little conflict due to simultaneous sessions because of the widely divergent subject treated.

Perhaps the best exemplification of what a modern convention should accomplish was afforded by the National Electric Light Association last June. Individual papers were few and far between, comprehensive reports of committees constituting the greater part of the program. These represented the essence of many men's efforts and were in form for ready adoption or rejection.

PERSONALS

E. Wilson, electrical dealer at Napa, Cal., spent a few days at San Francisco.

C. V. Schneider, electrical contractor, Sacramento, spent a few days during the week at San Francisco.

John B. Miller, president of the Southern California Edison Company, of Los Angeles, is at San Francisco.

W. A. Brackenridge, vice-president and general manager of the Southern California Edison Company, is at San Francisco.

C. G. Gauntlett, manager for the Safety Insulated Wire & Cable Company at San Francisco, has returned from New York City.

John W. Upp, manager of the switchboard department of the General Electric Company, is at San Francisco from Schenectady.

F. D. Newbury of the engineering department, Westinghouse Electric & Manufacturing Company, Pittsburg., Pa., is at San Francisco.

T. R. Lansborough, electrical engineer of the Tonopah Extension mine, Tonopah, Nevada, spent a few days during the week at San Francisco.

J. W. Upp, manager of the switchboard department, General Electric Company, Schenectady, New York, recently spent a few days at San Francisco.

John H. Finney, manager of the Aluminum Company of America, at Washington, D. C., attended the water power conference at Portland, during the past week.

E. H. Jacobs, superintendent of distribution of the Western States Gas & Electric Company, Stockton, Cal., spent the first part of the week at San Francisco.

S. P. Russell of the electrical department, H. W. Johns-Manville Company, San Francisco, returned the first of the week from a Southern California business trip.

G. B. Rosenblatt, metal mining engineer, Westinghouse Electric & Manufacturing Company, Salt Lake City, Utah, is spending a couple of weeks at San Francisco.

Geo. C. Ramsdell, secretary of the American Gas Institute, and of the International Gas Congress, is at San Francisco arranging for the convention to be held next week.

R. M. Alvord, manager supply department General Electric Company, San Francisco, returned the first of the week from a several weeks' business trip through the East.

C. E. Heise, manager Westinghouse Electric Manufacturing Company, San Francisco, returned the first of the week from a two weeks' trip through the central California counties.

G. F. Swain, professor of civil engineering in the Harvard Graduate School of Applied Sciences, and president of the Massachusetts Public Service Commission is at San Francisco.

E. Blake, engineer of the supply department, General Electric Company, Schenectady, who is on a business trip to the Pacific Coast, recently spent a few days at San Francisco.

D. W. Beldon, general salesman for Texas and Arizona of the Westinghouse Electric & Manufacturing Company, located at El Paso, Texas, is spending a few days at San Francisco.

C. E. Thompson of the treasury department, Westinghouse Electric & Manufacturing Company, San Francisco, returned the first of the week from a business trip to Los Angeles, Cal.

Charles A. Rolfe, president of the Southwestern Home Telephone Company at Redlands, California, attended the meeting of the Telephone Pioneers of America at San Francisco this week.

M. C. Morrow, heating appliance campaign manager for the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is at present at San Francisco and expects to make a business trip to Los Angeles shortly.

Chas. T. Johnson, president Dover Manufacturing Company, Canal Dover, Ohio, who has been spending some weeks at San Francisco, left the first of the week for a short trip to Los Angeles, Cal.

Wm. G. B. Euler, superintendent of operation and maintenance for the Great Western Power Company, and **F. H. Woodward,** sales manager for the company, escorted a party of visiting engineers to the Big Bend development of the company last week.

William E. Keily, recently associate editor of the Electrical World, has opened an office in the Edison Building, Chicago, as a specialist on literary and consulting work having to do with public utility problems and relations.

Geo. J. Henry, consulting hydraulic engineer, is at Los Angeles in connection with a suit which he has brought against the city because of alleged infringement of his patents on the control of the water wheels installed in the Los Angelus aqueduct power plants.

P. M. Downing, engineer of operation and maintenance for the Pacific Gas & Electric Company, had charge of a party of engineers who inspected the Lake Spalding development this week, the party including W. A. Doble, San Francisco; L. H. Miskian, San Francisco; Eugene F. Kreigsman, San Francisco; J. H. Dockweiler, San Francisco; A. L. Trowbridge, San Francisco; John B. Fisken, Spokane; H. F. Geiswold, Berkeley; H. W. Dennis, Los Angelse; Percy H. Thomas, New York; R. F. Schuphardt, Chicago; Charles A. Baker, New York; F. F. Foote, Jr., Berkeley, and H. H. Kriegsman, Sunnyvale.

Thomas A. Edison, chairman; **Dr. W. R. Whitney** and **L. H. Baekeland,** of the American Chemical Society; **F. J. Sprague** and **B. G. Lamme,** of the American Institute of Electrical Engineers; **A. M. Hunt** and **Alfred Craven,** of the American Society of Civil Engineers; **Dr. R. S. Woodward** and **Dr. A. G. Webster,** of the American Mathematical Society; **M. B. Sellers** and **H. Maxim,** of the American Aeronautical Society; **Dr. Peter Cooper Hewitt** and **Thomas Robins,** of the Inventors' Guild; **H. E. Coffin** and **A. L. Riker,** of the American Society of Automobile Engineers; **W. L. Saunders** and **B. B. Thayer,** of the American Institute of Mining Engineers; **Dr. J. W. Richards** and **L. Addicks,** of the American Electrochemical Society; **W. LeRoy Emmet** and **Spencer Miller,** of the American Society of Mechanical Engineers, and **H. A. W. Wood** and **E. A. Sperry,** of the American Society of Aeronautic Engineers, have been appointed members of the U. S. Naval Advisory Board.

MEETING NOTICES.

International Gas Congress.

Sessions of the International Gas Congress will be held at San Francisco September 27 to October 2, in conjunction with the American Gas Institute. A comprehensive program of papers and entertainment have been arranged and every indication points to a most successful meeting with at least six hundred in attendance.

Telephone Pioneers of America.

The annual meeting of the Telephone Pioneers of America was held at the Hotel St. Francis, San Francisco, during the past week, over three hundred members being in attendance. A banquet was held on Tuesday evening, a trip was taken to Mt. Tamalpais on Wednesday and a medal presented by the Exposition authorities on Thursday.

Portland Electrical Club.

The Thursday noon luncheon of the Portland Electric Club, successor to the Jovian Club, was held September 16 at the Commercial Club dining room with a large attendance.

F. I. Fuller, vice-president, and Fred Cooper, superintendent of transportation for the Portland Railway, Light and Power Company, recounted the early history of street car traffic in Portland in a most interesting manner.

International Engineering Congress.

The opening session of the International Engineering Congress was held at San Francisco on September 20 in the Municipal Auditorium. An address of welcome was given by the Mayor and an extended address by Major General Goethals and Major B. Pulligry of France. Technical sessions were continued during the day and week. An account of those proceedings coming within the scope of this Journal will be published in these columns next week.

Electrical Development and Jovian League.

The September 15th meeting was held at the Palace Hotel, eighty members being present. President Holberton presided and thanked the Live Wire Committee on its ability to secure the new meeting place which was heartily approved by all the members present. The first report of the new membership committee showed five additional members to the roll. President Holberton announced that should any member desire to be represented or serve, in addition to those already appointed on the standard specification committee, he would be glad to appoint such member to serve on same. Mr. E. M. Cutting was announced as chairman of the day, who introduced as his speaker Dr. J. L. Hall, representing the Emerson School of Efficiency on the Pacific Coast. Dr. Hall gave an interesting twenty-minute talk on the principles of efficiency as applied to every day business. The meeting closed with a hearty vote of thanks to both the speaker and chairman of the day.

Joint Meeting of the Engineering Societies of Southern California.

Before a well-attended meeting of the Engineering Societies of Southern California, held on September 15th, in the ballroom of the Jonathan Club, Los Angeles, Major-General G. W. Goethals freely and most interestedly discussed various phases connected with the building of the Panama Canal. His brief address dealt chiefly with the cause and prevention of slides, and he made many facetious references to the geologist who assured him that there would be no slides and told him that dikes of rock they uncovered were "trap rock," a ledge that is safe to build on. In answer to numerous questions, the general discussed canal fortifications, the establishment of warehouses, the canal's financial status, internal government and engineering features of general interest, apparently feeling very much at home among his felllow engineers. F. E. Trask, consulting engineer, presided over the meeting.

American Society of Mechanical Engineers.

The meeting of the American Society of Mechanical Engineers at San Francisco, September 16 and 17, was the largest and most successful ever held on the Pacific Coast. It was made notable by the presence of many Eastern and foreign engineers, who expected to attend the International Engineering Congress. These included John A. Brashear, president, and Calvin W. Rice, secretary.

The opening session on Thursday morning was addressed by Chas. C. Moore, president of the Exposition. The response to his adddress of welcome was given by Geo. W. Dickie, vice-president of the society. Guy L. Bayley, electrical and mechanical engineer for the Exposition, read a paper on its engineering features, and Geo. W. Dickie read one on mechanical engineering exhibits at the Exposition.

On Thursday afternoon a luncheon was tendered the visiting members and guests at the Exposition, which was visited in the afternoon, in the course of which a medal was presented to the society by the Exposition.

The following papers were read on Friday morning: "The Heavy Oil Engine, Its Present Status and Future Development," A. H. Goldingham; "The Diesel Engine and Its Applications in Southern California," W. H. Adams; "The Strength of Gear Teeth," G. H. Marx and L. E. Cutter.

The balance of the time was devoted to excursions to various points of engineering interest in the vicinity, including an inspection of the new Jones oil gas process at the Potrero works of the Pacific Gas & Electric Company.

FINAL HEARING FOR MINE SAFETY RULES.

On Saturday, September 25, 1915, at 407 Underwood building, 525 Market street, San Francisco, commencing at 9:30 A. M., the Industrial Accident Commission will hold the second public hearing to consider mine safety rules for California. At the public hearing which was held on June 11th, 12th and 14th, a number of sections were sent back to the committee to be redrafted. Most of the discussion will be on these redrafted sections.

NEWS OF IDAHO PUBLIC UTILITIES COMMISSION.

The Commission has granted permission to the Electric Investment Company of Boise to erect a temporary distribution system for the purpose of furnishing lighting service for the use of the Farm Market Bureau until such time as market is held during the evenings continuously, when a permanent system shall be installed.

The Commission has dismissed, overruled and denied the complaint of J. T. Wiseman et al. against the Rupert Electrical Company.

RULING ON GAS FILLED INCANDESCENT LAMP.

James M. Barry, chief of the San Francisco Department of Electricity, has advised electrical contractors and dealers that the increased use of Type "C" Mazda lamps for interior use in indirect and other ceiling fixtures demands that this department adopt regulations for their installation, which will not impose the unnecessary restrictions of Section 1, Ordinance No. 2582. At the time Ordinance No. 2582 was adopted, the gas filled lamp had not yet been brought out and no provisions for its installation are made in the ordinance. This department therefore, proposed to permit the installation of Type "C" Mazda lamps in accordance with the recommendation of the lamp committee of the National Electric Light Association and the Electrical Committee of the National Board of Fire Underwriters, adopted March 24, 1915, provided special permission in writing is obtained from the Chief of the Department of Electricity, in advance:

35 "(A) Must be so grouped that not more than 660 watts (nor more than 16 sockets or receptacles) are to be dependent on one cut-out, except that in cases where wiring equal in size to No. 14 B. & S. gauge is carried directly into keyless sockets or receptacles, the location of which is such as to render unlikely the attachment of flexible cord thereto, the circuits may be so arranged that not more than 1320 watts (or 32 sockets or receptacles) will be dependent on the final cut-out. Where a single socket or receptacle is used on a circuit, the limitation of watts permissible on the final cut-out shall be the maximum capacity for which such socket or receptacle is approved.

"(B) Must not be used in show windows or in other locations where inflammable material is liable to come in contact with lamp equipment, except where used in connection with approved fixtures where temperature of any exposed portion of same does not exceed 200 degrees fahrenheit (93 degrees centigrade).

"(C) Must not be used in connection with medium base sockets or receptacles if of above 200-watts nominal capacity, nor with mogul base sockets or receptacles if of above 1500 watts capacity. Must not if provided with a shade, reflector, fixture or other enclosure above the socket, be used in fibre-lined or similar sockets or receptacles of either medium or mogul base types if of above 100 watts.

"(D) Fixtures within buildings must be wired with conductors of approved slow-burning or asbestos covering where the temperature to which wire is subjected at any point exceeds 120 degrees fahrenheit (49 degrees centigrade). Where fixtures are placed outside of buildings approved rubber-insulated wire is required."

This rule supersedes any previous rule of this department relative to the installation of gas filled lamps.

INDUSTRIAL

THOMAS METERS MEASURING GAS SUPPLIED TO PANAMA-PACIFIC EXPOSITION.

When the Pacific Gas & Electric Company contracted to furnish all the gas to the Exposition grounds there arose the necessity of measuring the total quantities supplied to the Exposition and to the Zone respectively, and it was essential that this measurement be made in lines in which the gas pressure varied from 30 to 50 lb. gauge. To measure the gas under these varying conditions Thomas meters were

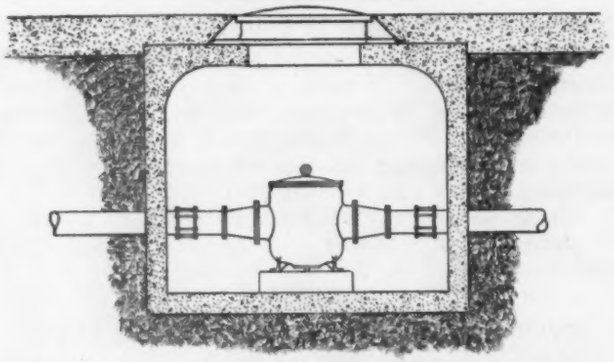

Fig. 1. Cross Section of Underground Pit Showing Thomas Meter Installed in Gas Line.

chosen. These meters, which are installed in underground pits in the gas line, give results directly in standard cubic feet regardless of the variations in pressure.

Fig. 1 shows one of the pits and Fig. 2 the small building in which the recording panels are housed. This building is of the Exposition grounds just to the rear of the "Old Red Mill" and the pits containing the housings are each about 500 ft. distant, one located in the line supplying the Exposi-

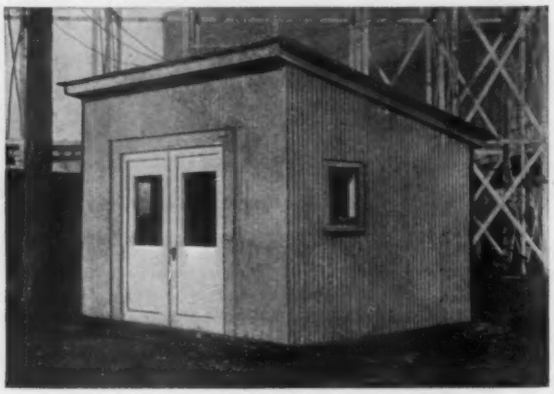

Fig. 2. Small Building Just to the Rear of the "Old Red Mill" which Houses the Recording Panels for Both Thomas Meters.

tion proper, and the other in the line supplying the Zone. Underground wiring in conduit connects the two parts.

The Thomas meter operates on the principle of measuring electrically the heat required to raise the temperature of the flowing gas two degrees Fahrenheit. The heat capacity of the standard unit, that is, the quantity of heat required to warm a standard cubic foot through a known temperature range, remains essentially the same when the pressure and temperature of the gas change. The meter dial and chart therefore always register standard units of gas whatever may be the pressure, temperature, or volumetic conditions of these standard units at the point of measurement. No corrections whatever need be applied for gas temperature, pressure, or gravity, or for barometer reading. The meter is entirely automatic in every respect and requires very little attention and care.

The broad basic principle of the Thomas meter makes it adaptable to many different classes of commercial gas measurement. The accompanying picture taken from an installation in the Racine plant of the Wisconsin Gas & Electric Company, Racine, Wis., illustrates its application to station meter service in a modern coal gas plant. Prominent among its advantages over former methods of measurement in this service is the graphic chart which shows a continuous record of the rate of gas made.

Another interesting Thomas meter installation is being made by the Kansas Natural Gas Company to measure at the city gates the total quantity of gas supplied to Kansas City, Kansas. Here again the ability to measure gases at widely varying pressure and rates of flow and to give results in standard cubic feet on both a dial and graphic chart are essential features. The Thomas meter for measuring gas is made by The Cutler-Hammer Manufacturing Company, Milwaukee.

NEW CATALOGUES.

"A Chain of Evidence," Publication No. 13, from the Morse Chain Company, illustrates and describes the application of Morse silent chains to textile mills.

No. 4 of the Westinghouse Lamp Company's salesmen's lamp handbook series is devoted to The Mazda C Lamp. Its manufacture and application are described and many facts not ordinarily understood are fully explained.

The Busch-Sulzer Bros.-Diesel Engine Company are distributing from their San Francisco office bulletins No. 299 describing the results obtained from a Diesel engine in the municipal plant of Kiowa, Kansas, and No. 2004 describing the Diesel engine driven pumping plant of the city of Appleton, Wisconsin.

Novalux street lighting units for Mazda series lamps is the subject of an interesting data book from the General Electric Company. Details are given of various sizes, together with directions for installation and use. Constant current transformers for use on these systems are illustrated and described in an accompanying booklet.

The Hurley Machine Company's new catalogue "C" on the Thor Electric washing and ironing machines, is being distributed by the Pacific States Electric Company, San Francisco. The catalogue illustrates in detail the various styles of machines made by the Hurley Company, three carloads of which have been distributed on the Pacific Coast within the last 60 days.

TRADE NOTES.

The Rex Electric Company has moved into its new store, 1174 Sutter street, San Francisco.

The Illinois Electric Company, Los Angeles, has been appointed jobbing sales agent for Brascolite ceiling fixtures.

City Electrician Manahan of Los Angeles and the Fire Commission will report to the council favoring an amendment to the electric sign ordinance permitting vertical signs on buildings of four stories and higher to be 48 in. wide. The present ordinance puts the width of all signs at 30 in., and the new change will allow 36 in. for signs on three-story buildings and 48 in. on those of four stories and higher.

NEWS NOTES

ILLUMINATION.

OAKLAND, CAL.—The contract for the construction of 16 lighting posts in Telegraph avenue has been awarded to F. I. Carson.

KENDRICK, IDAHO.—The council has granted a franchise to A. V. Dunkle, Plummer, Idaho, for the installation and operation of an electric light plant to cost $10,000.

LOS ANGELES, CAL.—The city council has prepared an ordinance for ornamental lights for the portion of Hobart Boulevard between Washington and Sixteenth streets.

PASADENA, CAL.—At the election on October 16th, a $25,000 bond issue will be voted upon for ornamental lights, extending over an area of 18 miles, at Lamanda Park.

RED BLUFF, CAL.—The board of trustees has taken steps toward securing a cheaper lighting system, either by purchasing the present system or by installing a new system.

BUENA PARK, CAL.—The Southern California Edison Company's bid of $1.25 per 32 candlepower tungsten lamp per month for lighting the new Buena Park district, has been accepted.

ORANGE, CAL.—The city may decide to install a municipal plant unless the Southern California Edison Company grants lower rates. The city council is to confer with the Edison Company in regard to rates.

PHOENIX, ARIZ.—The board of county supervisors has granted to L. G. Wilson a franchise to build lighting and power lines connecting Gilbert townsite and adjoining lands with the government line to Sacaton.

SEATTLE, WASH.—A light and power franchise has been granted to the Puget Sound Traction, Light & Power Company by the board of county commissioners. The franchise extends over the entire southern portion of King county.

TROPICO, CAL.—At a meeting of the board of trustees a petition signed by property owners on San Fernando Boulevard, from Brand Boulevard to Tropico avenue, calling for lighting posts, was presented and the city engineer instructed to prepare plans and specifications.

BELLINGHAM, WASH.—The city council declared in favor of the nitrogen tungsten system of lighting for Bellingham, by passing an ordinance authorizing a five year contract with the Puget Sound Traction, Light & Power Company for the installation of that system.

TUCSON ARIZ.—An improvement bond issue of $100,000 has been recommended to the city council by City Manager C. K. Clarke. Of this sum $50,374 is needed to complete the ornamental lighting system on Broadway, Toole, South Sixth, North Sixth, South Fifth, South Fourth, South Third, Granada, Main, Alameda, Pasco, Redondo, Church, Court, St. Mary and Franklin streets.

TRANSPORTATION.

SALEM, ORE.—Mr. Hirschberg, who owns 2½ miles of steam railroad between Independence and Monmouth, is seriously considering the electrification of his line.

LOS ANGELES, CAL.—The Pacific Electric Railway has notified the harbor commission that it will without delay commence electrifying the city's harbor railway lines.

BILLINGS, MONT.—The survey for the electric line from Nye to Cooke City is under way is the statement of Mayor E. A. Gerhart. The road is to provide transportation for minerals.

PASADENA, CAL.—Steps to secure an electric road to Brookside park, are being discussed, and it is expected the city commission will ask the Pacific Electric to build a direct line to the park.

EL PASO, TEXAS.—The city council has adopted an ordinance granting to the El Paso Electric Railway the right to operate an electric railway over Piedras street, between Alameda andd Boulevard streets.

LOS ANGELES, CAL.—President Shoup of the Pacific Electric Railway has presented to the board of public utilities plans for remodeling Hill street station and trackage at approximate expense of $30,000.

LOS ANGELES, CAL.—The municipal belt line at the harbor will be electrified by the Pacific Electric Railway, this being the only bid on the work, which affects 6½ miles of line. The figure was placed at $3460.

LOS ANGELES, CAL.—P. D. Cornelius has been granted a franchise to construct and for a period of 21 years, to operate a double track electric street railway over portions of Brooklyn avenue, Evergreen avenue, Wabash avenue, etc.

BOISE, IDAHO.—The contract for the construction of a connecting link of street car line between the present terminal of the Thirteenth street line and the Soldiers' Home line has been let by the Boise Railroad Company to S. E. Burnham.

EL SEGUNDO, CAL.—The Hermosa Beach Chamber of Commerce has taken steps to obtain a five-mile right-of-way to build a railroad connecting with the Short Line of Pacific Electric Company at Belvedere, leading into Los Angeles over the Gardena Route.

SOUTH SAN FRANCISCO, CAL.—The city trustees have awarded the South San Francisco Railroad & Power Company a franchise to operate a single or double track electric road over the extension of Grand avenue to the northeasterly line of the Mission road. This will give South City a new connection with San Francisco.

SANTA ANA, CAL.—The city clerk has received two applications from the Pacific Electric Railway: One for permission to construct a double tracked curve from West Fourth street, north on to Main street, connecting with the Orange line; the other for permission to construct a siding on North Main street, beyond the Southern Pacific tracks and connecting with the Southern Pacific.

MODESTO, CAL.—A franchise for a right-of-way through the unincorporated town of Ceres, five miles south of Modesto, has been granted by the county board of supervisors to the Tidewater Southern. The franchise was sought by the Tidewater to enable extension of the electric line now running from Stockton to Modesto on to Turlock, an improvement for which the right of way through the country district has already been secured.

SAN FRANCISCO, CAL.—In reference to the Church street Municipal Railway, Assistant Engineer Ransom states that plans and specifications are ready, contracts for materials awarded and the construction can begin when Judge Seawell decides the injunction case relative to the purchase of a right of way between Twentieth and Twenty-second streets, and when the question of either using the United Railroads tracks on Market street, or laying other tracks is determined by the supervisors.

SAN FRANCISCO, CAL.—City Attorney Percy V. Long has given an opinion that the board of park commissioners possess the power to grant an easement in Mission Park for the proposed Church street Municipal railway. His opinion was requested by the park commission, which has been asked by the supervisors to grant the right of way through Mission Park and is to be asked to permit the extension of the Tenth avenue branch of the Geary street municipal line across Golden Gate Park to Lincoln way.

TELEPHONE AND TELEGRAPH.

BAKER, ORE.—The county court has granted a franchise to the McEwen Telephone Company to extend its services.

SAN DIEGO, CAL.—The Pacific Telephone & Telegraph Company has applied for a franchise to lay underground wires for telephone and telegraph purposes in the public highways of East San Diego. Sealed bids will be received up to September 20th for the franchise.

LONG BEACH, CAL.—With the filing of a request by the Home Telephone Company for a year's extension for carrying out the terms of the ordinance requiring the placing of all telephone lines in the business section in underground conduits, has revived the report that a movement for the consolidation of the telephone systems of the Home and Sunset Telephone Companies in this city. The request of the Home company was taken under advisement.

OGDEN, UTAH.—One hundred thousand dollars will be spent by the Mountain States Telephone & Telegraph Company on improvements to the local system before the winter sets in. This is the estimated amount for the underground work now in course of construction. The work of laying the conduits is now in progress. Overhead wires and cables on Washington avenue from Twelfth to Thirty-second streets, will come down. Diverging from the main feeds on Washington avenue will be other feeders, or laterals, leading in different directions. These also will be underground.

MARSHFIELD, ORE.—Naval inspectors George E. Hanscom and Lieutenant Blankenship of the Mare Island Navy Yard have chosen a site for the new wireless station to be located on Coos Bay, and selected a strip of marsh land 887x200, two miles from Marshfield, on Coalbank Inlet. The station will have two towers not less than 300 ft. in height and perhaps between 400 and 500. The radio will cover a diameter of 400 miles. Work on the construction will be started within the next few weeks.

WATERWORKS.

OROVILLE, CAL.—Frank Barnard has been granted a franchise for a water system in Durham.

ST. MARIES, IDAHO.—The contract for the construction of a waterworks system in St. Maries has been awarded to W. L. Geist at $29,110.

COLUSA, CAL.—Engineer T. L. T. Brown has been authorized to purchase the necessary pipe to connect the county hospital with the city water system.

KELLOGG, IDAHO.—An ordinance has been passed by the city council granting to the Kellogg Power & Water Company a franchise to supply the city with water.

AUBURN, WASH.—To create a water improvement district in Railroad addition, a solution will be submitted at a meeting to be held October 6th, by the city engineer, and the water committee.

TACOMA, WASH.—The board of county commissioners has set the date of hearing of the application of the city of Puyallup for permission to lay water mains along the county roads for October 2.

ABERDEEN, WASH.—Another bond election will be held to vote on the Wishkah Water project bonds. The election will be held September 25th, and the amount of the bonds this time will be $400,000.

McMINNVILLE, ORE.—It has been decided that the water in Haskins Creek will not hold up to the amount needed, so that source has been abandoned. No information is given in regard to other plans.

TWIN FALLS, IDAHO.—The city council has rejected the offer from the Twin Falls Waterworks Company of $92,500. The offer was met with a lower counter offer of $60,000, introduced by Councilman Bobier. It now appears that the city is ready to purchase at the above price, payable in bonds.

SAN FERNANDO, CAL.—In order to get a distributing system put in by which to use Los Angeles aqueduct water, residents of San Fernando Mission land section are contemplating forming a district and voting bonds.

HUNTINGTON BEACH, CAL.—An ordinance has been adopted granting to the Huntington Beach Company a franchise to lay down and maintain a system of water pipe lines along public roads and streets in Orange county.

SANTA CRUZ, CAL.—Representatives of the F. A. Hihn Company appeared before the city commissioners recently and offered to sell their entire water system including, water rights, reservoirs, mains, etc., to the city for $78,000.

ST. HELENS, ORE.—The St. Helens board of water commissioners are making arrangements to run a pipe line from Milton Creek to connect with the 10 in. main running into the city. The connection will be made about 9 miles up the creek.

FAIRVIEW, ORE.—The city of Fairview is making plans for a municipal water system and will take a vote on the proposition at the regular annual election in December. A bond issue of $12,000 is also to be voted on for the purpose of boring a well and laying pipes.

MARTINEZ, CAL.—According to figures submitted by Elam C. Brown, city engineer, it will cost $43,000 to install a water system such as the board has under contemplation. This includes reservoir and laying of pipe lines from the municipal wharf to the reservoir and laying suitable mains throughout the city.

LOS ANGELES, CAL.—W. B. Matthews, special counsel of the water department, has urged the city council to arrange for the immediate installation of a municipal street lighting system in conjunction with the city's power system. His rrequest has the approval of E. Scattergood, electrical engineer of the power bureau.

RAYMOND, WASH.—The city of Raymond has taken over the waterworks from the Raymond Water Company, paying $93,881.52 for the system, bonds for which were issued in the spring. Plans of extending the system up the South Fork River have been under way for some time. When the extension is completed the cost of which will be $100,000, the city will have a gravity system, and a good supply of water.

BAKER CITY, ORE.—On account of water shortage, Mayor C. L. Palmer has stated that it is the duty of the commissioners to submit to the people of Baker the proposition of issuing bonds to extend the present water system, to include all possible sources of supply. According to estimates the work will cost $1,10,000.

SALEM, ORE.—State Engineer Lewis has approved plans for Suttles Lake Irrigation District for issuance of $600,000 in bonds for the irrigation of 12,000 acres, including the construction of a 58-ft. dam, with 21,500 acre feet of water capacity, 18 miles of canal. Geo. S. Young of Bend, Ore., is project engineer. O. Laurgaard, Portland, consulting engineer.

NEWPORT, ORE.—Newport has been granted a permit to use 24 cu. ft. of the waters of Spencer Creek for municipal purposes. The city will soon begin the construction of the works on the creek. This will consist of a dam 9 ft. long. The estimated cost is $24,000. The pipe line will be about 10 miles long, and will terminate in the new reservoir on the hill, near the city.

SONORA, CAL.—The farmers of the Rough and Ready district in this county have filed a petition with the Sierra and San Francisco Power Company asking to be supplied with water for irrigation. They ask for water from the Shawmut ditch near the McAuley property, coming from the Strawberry dam, and in return will guarantee to build new ditches and improve the old ones and take water as payment for their labor. They also guarantee to take 30 inches of water continuously from June 1 every year until the rains.